1963

Biostratigraphic Correlation of the Type Shubuta and Red Bluff Clays Withtheir Equivalents in Southwestern Alabama.

Phili B. Deboo
Louisiana State University and Agricultural & Mechanical College

DEBOO, Phili B., 1932–
BIOSTRATIGRAPHIC CORRELATION OF THE TYPE SHUBUTA AND RED BLUFF CLAYS WITH THEIR EQUIVALENTS IN SOUTHWESTERN ALABAMA.

Louisiana State University, Ph.D., 1963
Geology

BIOSTRATIGRAPHIC CORRELATION OF THE TYPE SHUBUTA AND RED BLUFF CLAYS WITH THEIR EQUIVALENTS IN SOUTHWESTERN ALABAMA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Geology

by
Phili B. Deboo
B.S., University of Bombay, 1953
M.S., Louisiana State University, 1955
June, 1963

ACKNOWLEDGMENTS

The writer wishes to express thanks to Dr. A. H. Cheetham and Dr. W. A. van den Bold for continued guidance and assistance throughout the research for this study and the preparation of the manuscript. The writer is also indebted to Dr. H. V. Andersen for his help with certain phases of this study and to Dr. H. V. Howe for making personal collections available which were of invaluable help to this research. Thanks are also due to Dr. H. V. Andersen, Dr. C. O. Durham and Dr. A. E. Sandberg for their perusal of the text.

Mr. Lewis Nichols helped in collecting some of the samples used and also prepared the photomicrographs for the microfossil plates. Considerable help was furnished by Mr. Philip LaMoreaux of the Alabama Geological Survey by making the drafting and reproduction facilities of the survey available for final preparation of this dissertation. The writer is grateful to Mr. Charles Copeland for his scrutiny of the range charts during preparation.

Lastly, many thanks are due my wife Martha for typing the preliminary drafts of this manuscript and for her help in the preparation of the range charts.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

Boundaries between time-stratigraphic units are established principally by paleontologic evidence, that is, at major and minor biostratigraphic discontinuities.

The present study is an attempt to establish a boundary between the Jacksonian and Vicksburgian Stages in eastern Mississippi and western Alabama and to determine its relation to that between the Eocene and Oligocene Series. For this problem occurrence data for three microfossil groups with widely different ecological control, ostracods, planktonic foraminifers, and benthonic foraminifers were analyzed. These data were obtained from samples collected from four continuously exposed sections in southwestern Alabama and one composite section in southeastern Mississippi ranging from the Cocoa Sand (Jacksonian) to the Marianna Limestone (Vicksburgian).

The range data were plotted on charts, and those for ostracods and planktonic foraminifers were analyzed visually. The benthonic foraminiferal fauna, however, is so diversified that a numerical index of comparison of vertically successive samples had to be used. For this purpose, Simpson's coefficient of faunal resemblance was found to be adequate.

The range data for all three groups form the basis of three major biostratigraphic assemblage units, *Floridina antiqua*, *Spondylus dumosus*, and *Lepidocyclina mantelli* zones, and two minor ones, *Cribrohantkenina* "*danvillensis*" and "*Cythereis*" *blanpiedi* subzones (of *Spondylus dumosus* zone). Simpson's coefficients for each of the taxonomic groups from one

zone to another are lower than for one subzone to another. Moreover, the coefficient of resemblance between the *Spondylus dumosus* zone, and the *Floridina* antiqua zone (Jacksonian) is considerably lower than that between the *Spondylus dumosus* zone and the *Lepidocyclina mantelli* zone (Vicksburgian). For this reason, it seems logical that the Jacksonian-Vicksburgian boundary be placed at the base of the *Spondylus dumosus* zone.

The presence of *Cribrohantkenina inflata*-bearing beds within the *Spondylus dumosus* zone, i. e., in the Vicksburgian, makes it improbable that the Jacksonian-Vicksburgian boundary is coincident with the Eocene-Oligocene boundary as most Gulf Coast stratigraphers have assumed. Furthermore, inasmuch as the upper Eocene part of the *Spondylus dumosus* zone (the *Cribrohantkenina* "*danvillensis*" subzone) passed upward through the "*Cythereis*" *blanpiedi* subzone into the *Lepidocyclina mantelli* zone (considered by some stratigraphers to be lower Miocene) without major discontinuity, the hypothesis that there are no sediments of Oligocene age in the Gulf Coast appears invalid.

Although the microfauna was studied in detail and all important species (58 ostracods and 165 foraminifers) are here illustrated, a complete taxonomic study has not been attempted. Brief nomenclatural notes are included for a few species.

INTRODUCTION

To establish the boundary between the Jacksonian and Vicksburgian Stages at a consistently recognizable discontinuity has been an objective of Gulf Coast stratigraphers for many years. Attempts to use lithology as the basis have not been successful because vertically successive rock types are often gradational or, in instances where there is an easily observed lithologic discontinuity, the hiatus is often very minor. Furthermore, the Jacksonian and Vicksburgian deposits change facies laterally from limestones in Florida and southeastern Alabama through marls and clays in southwestern Alabama to sands and clays farther west. Therefore the Jacksonian-Vicksburgian boundary, a time-stratigraphic surface, has been tenuously defined on the basis of lithology alone. Although many attempts have been made to fix the boundary paleontologically, none has involved the total fauna, or the majority of it. This paper reports the results of a biostratigraphic study in which a large section of the total fauna, including megafossils, benthonic foraminifers, pelagic foraminifers, and ostracods, has been used to identify and correlate this boundary in the critical area of facies change in eastern Mississippi and western Alabama.

Whatever its position in local sections, the surface between the two stages is usually regarded as the Eocene-Oligocene contact in the Gulf Coast. A different opinion is held by Eames et al. (1962), who, after a study of planktonic and larger foraminifers and molluscs, concluded that a period of nondeposition in the Gulf Coastal Plain extended throughout Oligocene time so that the disconformity between the Jacksonian and the Vicksburgian brings into contact rocks of upper Eocene and lower Miocene age. However, data obtained in the present study cast doubt upon the validity of the conlusion advanced by Eames _et al_. inasmuch as the horizon of _Cribrohantkenina_ "_danvillensis_," regarded by them as upper Eocene, lies above the major stratigraphic discontinuity, here considered the Jacksonian-Vicksburgian boundary. The upper contact of the _Cribrohantkenina inflata_-bearing beds is not a major biostratigraphic discontinuity, although it has been so regarded by many Gulf Coast stratigraphers.

The detailed biostratigraphic analysis upon which this paper is based made use of the classical sections in Mississippi and southwestern Alabama distributed over a distance of about fifty miles (fig. 1). The stratigraphic interval included ranges from the Cocoa (known Jacksonian) to the lower part of the Marianna (known Vicksburgian) (figs. 2, 3, 4-13). Between these units lie the Pachuta, Shubuta, Red Bluff, and Forest Hill sediments including marls, calcareous and carbonaceous clays and sands forming a sequence of beds which do not lie in simple, vertical succession.

Five sections have been studied in detail; four are continuously exposed sections in Alabama and one is a composite section in Mississippi. The continuous sections are exposed at classical Alabama localities, and their study was critical for establishing stratigraphic relationships. The composite section in Mississippi includes the type exposures of the Shubuta and Red Bluff Clays.

In each of the five sections, biostratigraphic units were established on the basis of vertical ranges (teilzones) of foraminifers and ostracods. These units were found to correlate laterally through the

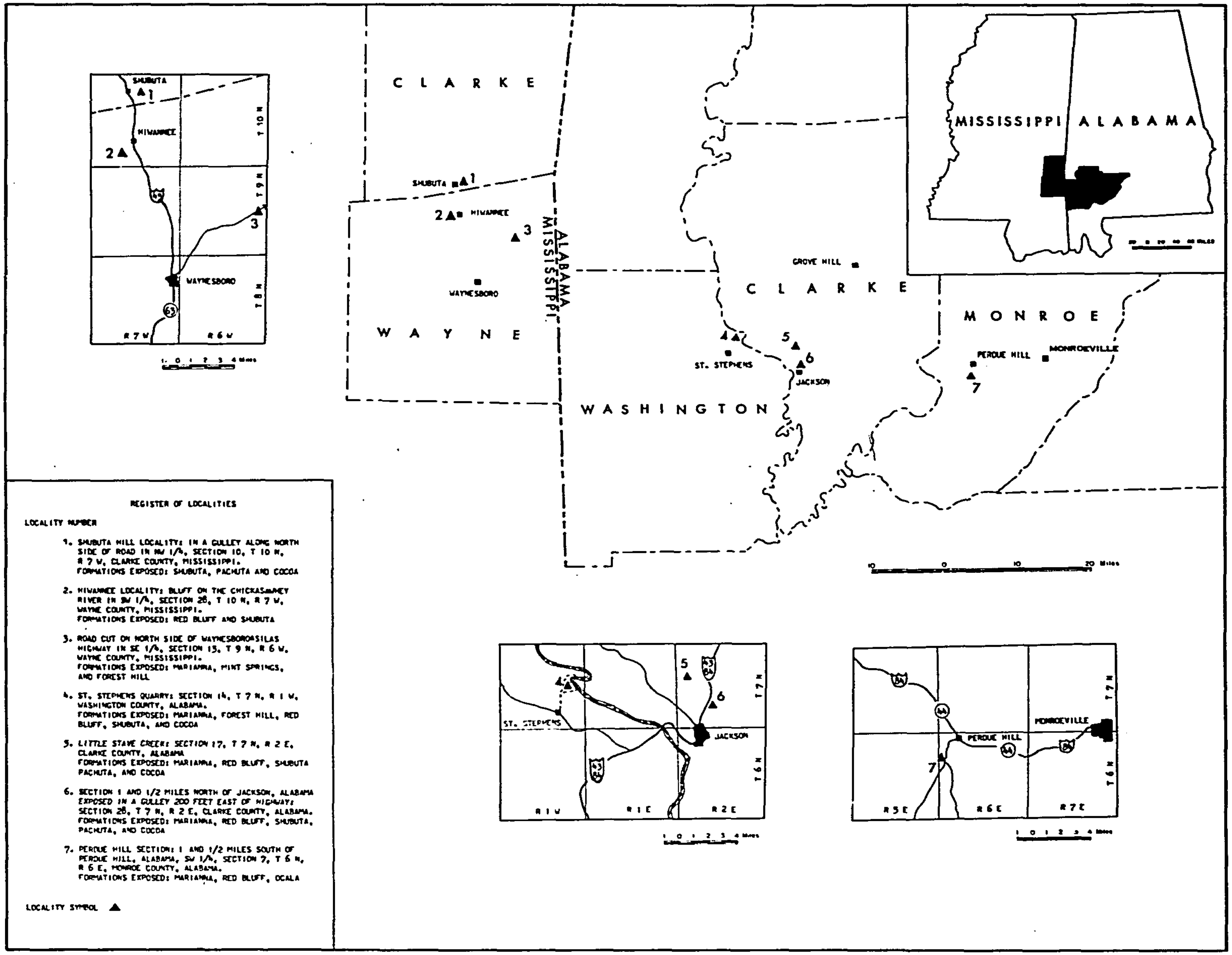


FIG. 1-- Area of study and register of localities.

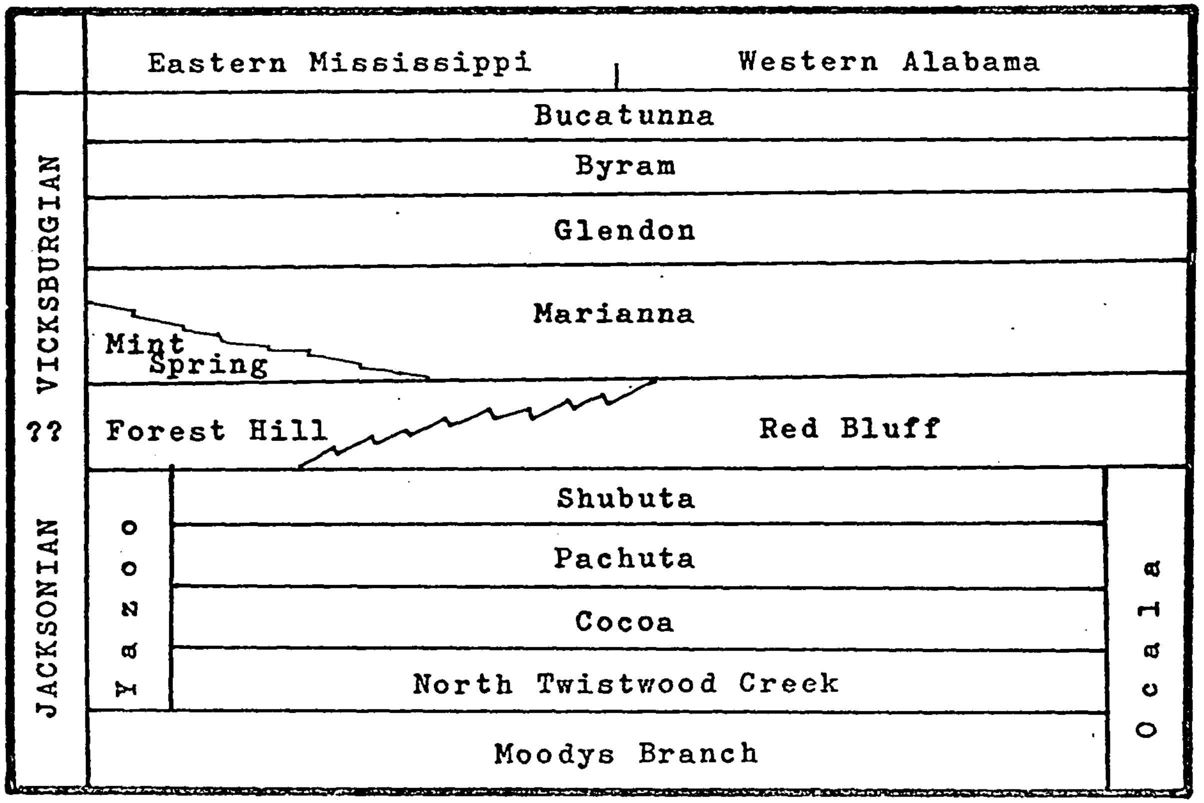


FIG. 2-- Generally accepted lithostratigraphic units of Jacksonian-Vicksburgian age in area of study.

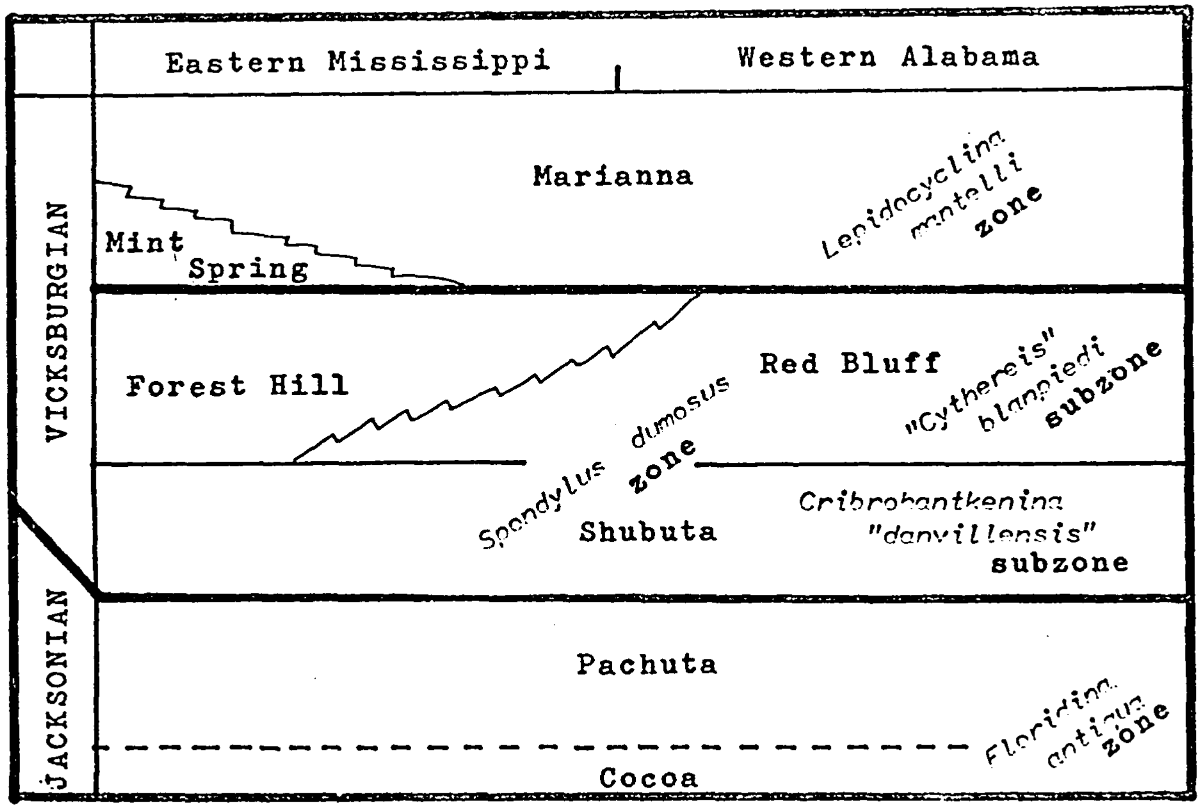
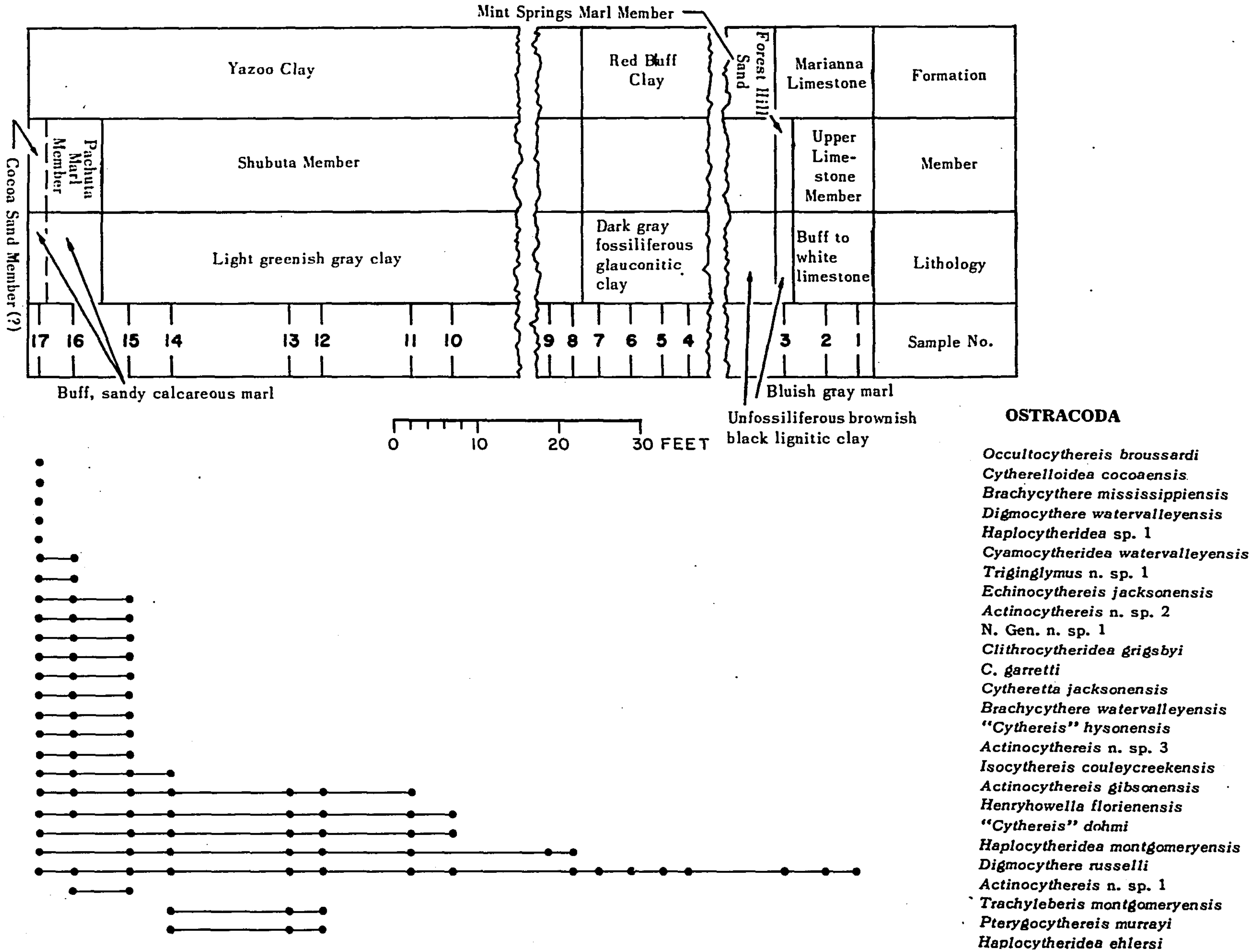


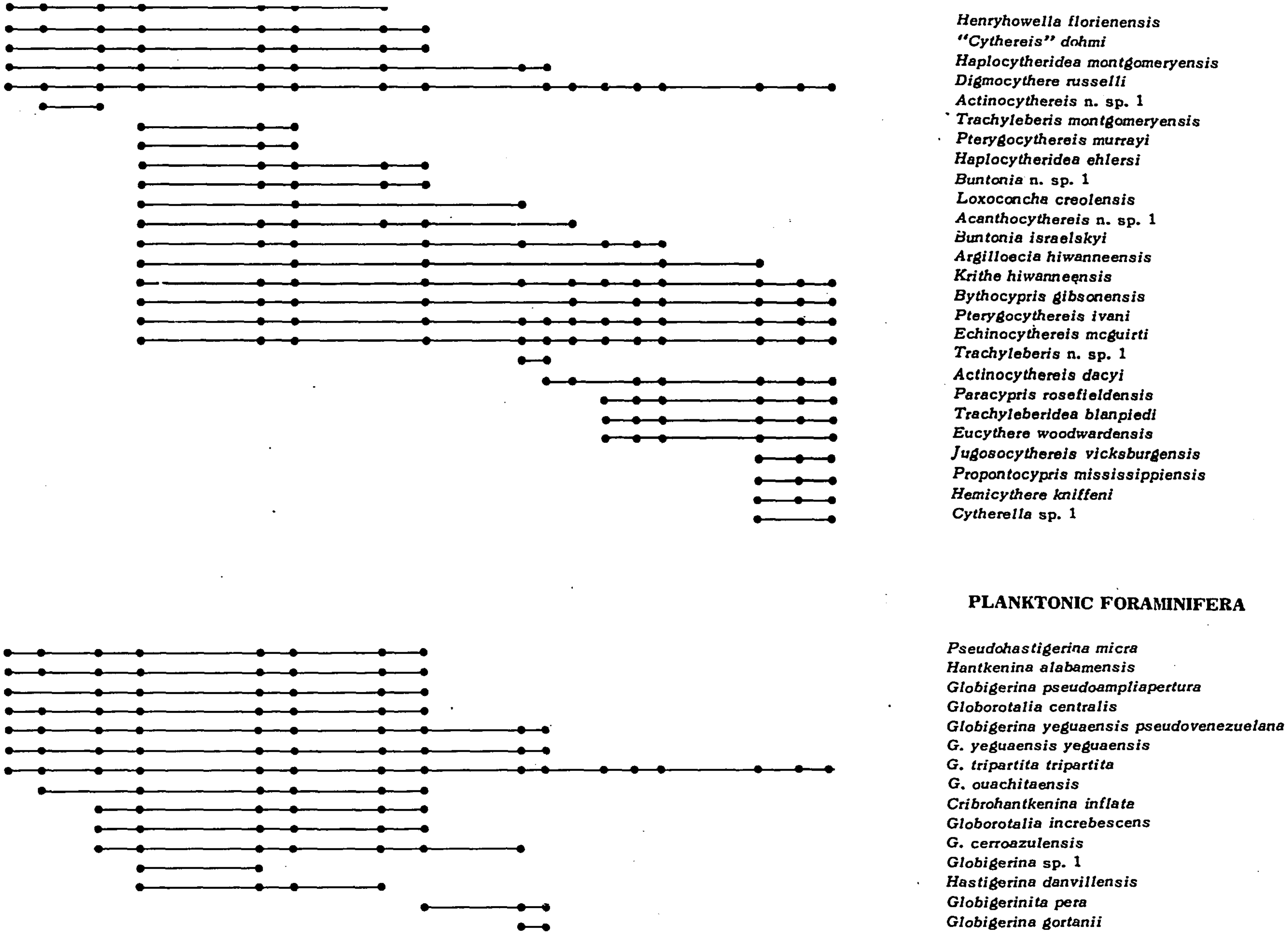
FIG. 3-- Relationships of biostratigraphic and lithostratigraphic units of Jacksonian-Vicksburgian age determined in the present study.

five sections (fig. 20, 21) as assemblage zones or faunizones and their subdivisions.

The contact between two of these units is a major discontinuity here regarded as the boundary between the Jacksonian and Vicksburgian Stages. The microfossils have been analyzed in detail as three separate units: (1) benthonic foraminifers, (2) planktonic foraminifers, and (3) ostracods. The range data for ostracods and planktonic foraminifers, of which there are comparatively few species, have been interpreted by visual inspection of range-chart plots (figs. 4-13). The much greater number of benthonic foraminiferal species makes visual interpretation extremely difficult and much less reliable. A numerical method of comparing vertically successive samples based on Simpson's (1960) coefficient of faunal resemblance, was found to give consistently satisfactory results in one of these sections (Cheetham and Deboo, 1963, MS.), and this method has been applied in this paper to the other four sections with the same degree of consistency. Although this method of faunal resemblance has not been used to compare ostracod and planktonic foraminiferal assemblages between adjacent samples, it has been used to compare them between successive zones and subzones (fig. 19). Those taxa that occurred in all of the samples studied, or those which were taxonomically enigmatic, have been omitted from the charts and computations.

The biostratigraphic analysis presented in this report has permitted recognition of three assemblage zones: the Floridina antiqua zone (Pachuta and Cocoa), the Spondylus dumosus zone (Shubuta, Red Bluff, and Forest Hill), and the Lepidocyclina mantelli zone (Mint Spring and Marianna). These three zones can be recognized throughout the eastern Gulf Coast region on the basis of their distinctive faunal assemblages.

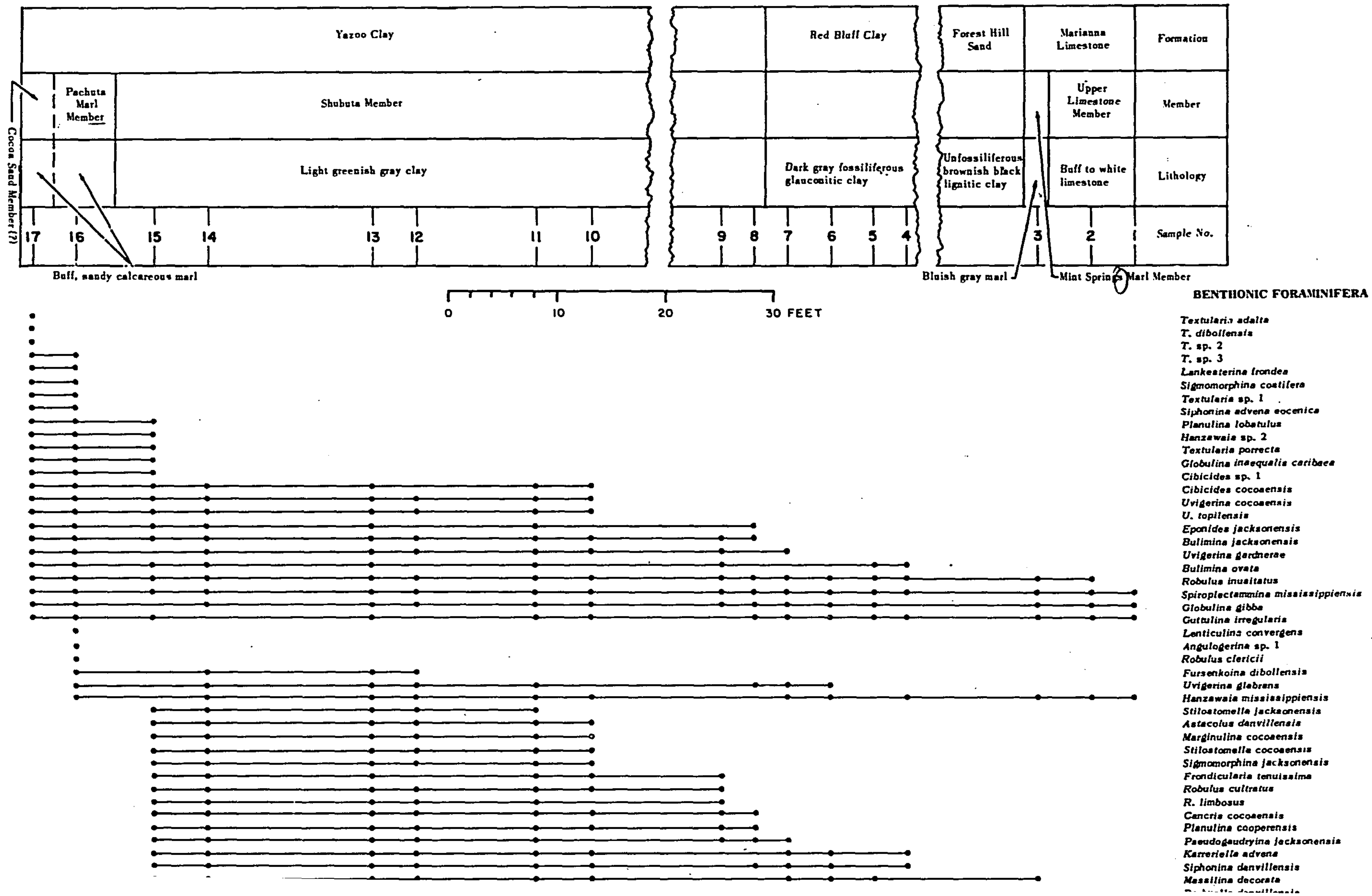

Mint Springs Marl Member
Yazoo Clay
Red Bluff Clay
Forest Hill Sand
Marianna Limestone
Formation
Cocoa Sand Member (?)
Pachuta Marl Member
Shubuta Member
Upper Limestone Member
Member
Light greenish gray clay
Dark gray fossiliferous glauconitic clay
Buff to white limestone
Lithology
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Sample No.
Buff, sandy calcareous marl
Bluish gray marl
Unfossiliferous brownish black lignitic clay
0 10 20 30 FEET
OSTRACODA
Occultocythereis broussardi
Cytherelloidea cocoaensis
Brachycythere mississippiensis
Digmocythere watervalleyensis
Haplocytheridea sp. 1
Cyamocytheridea watervalleyensis
Triginglymus n. sp. 1
Echinocythereis jacksonensis
Actinocythereis n. sp. 2
N. Gen. n. sp. 1
Clithrocytheridea grigsbyi
C. garretti
Cytheretta jacksonensis
Brachycythere watervalleyensis
"Cythereis" hysonensis
Actinocythereis n. sp. 3
Isocythereis couleycreekensis
Actinocythereis gibsonensis
Henryhowella florienensis
"Cythereis" dohmi
Haplocytheridea montgomeryensis
Digmocythere russelli
Actinocythereis n. sp. 1
Trachyleberis montgomeryensis
Pterygocythereis murrayi
Haplocytheridea ehlersi

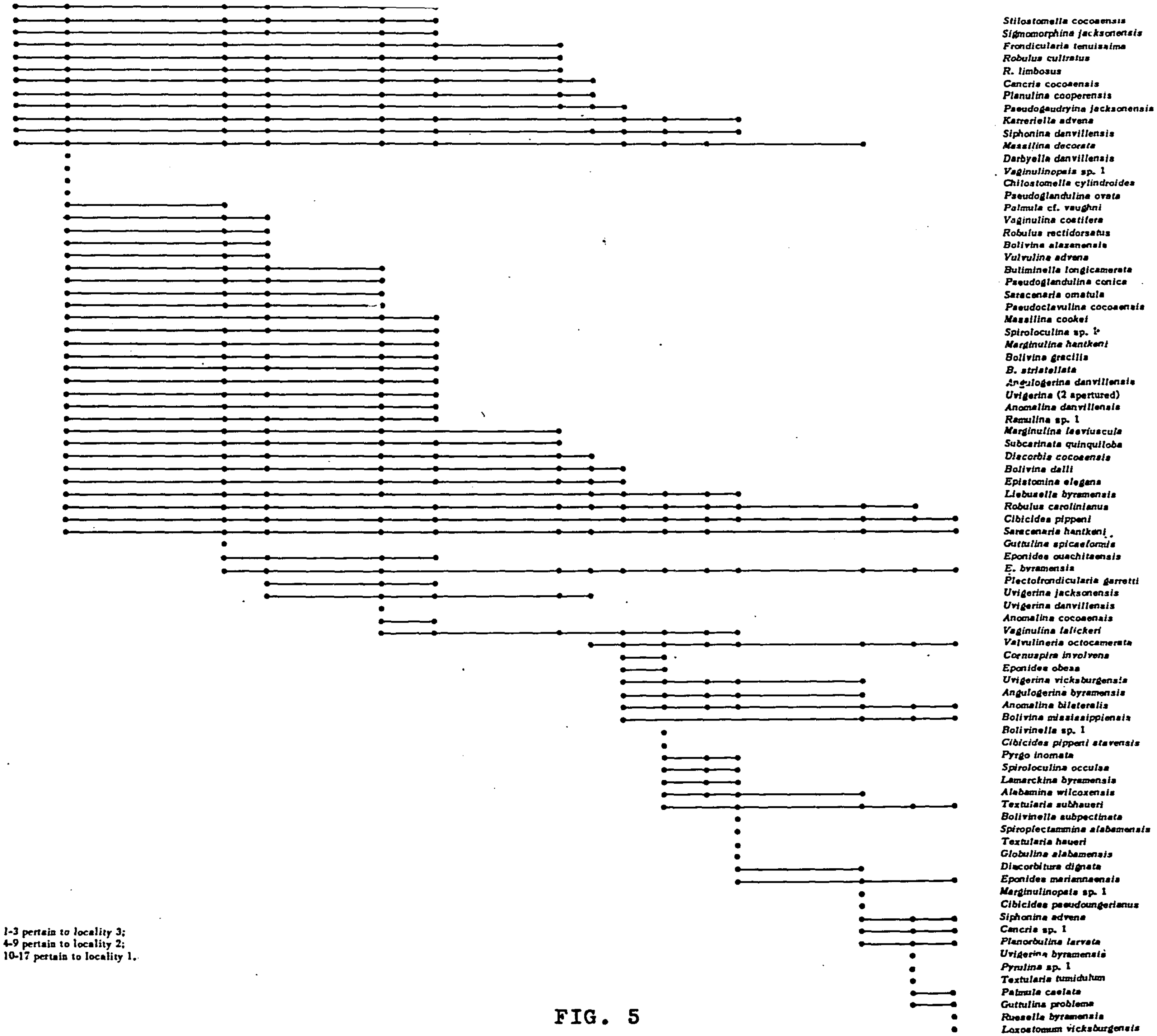


Note: Sample numbers 1-3 pertain to locality 3;
sample numbers 4-9 pertain to locality 2;
sample numbers 10-17 pertain to locality 1.

FIG. 1

Range Chart 1-A: Range Chart of Ostracoda and Planktonic Foraminifera and Composite Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Wayne and Clarke counties, Mississippi.


Yazoo Clay
Red Bluff Clay
Forest Hill Sand
Marianna Limestone
Formation
Pachuta Marl Member
Shubuta Member
Upper Limestone Member
Member
Cocoa Sand Member (?)
Light greenish gray clay
Dark gray fossiliferous glauconitic clay
Unfossiliferous brownish black lignitic clay
Buff to white limestone
Lithology
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2
Sample No.
Buff, sandy calcareous marl
Bluish gray marl
Mint Springs Marl Member
0 10 20 30 FEET
BENTHONIC FORAMINIFERA
Textularia adalta
T. dibollensis
T. sp. 2
T. sp. 3
Lankesterina frondea
Sigmomorphina costifera
Textularia sp. 1
Siphonina advena eocenica
Planulina lobatulus
Hanzawaia sp. 2
Textularia porrecta
Globulina inaequalis caribaea
Cibicides sp. 1
Cibicides cocoaensis
Uvigerina cocoaensis
U. topilensis
Eponides jacksonensis
Bulimina jacksonensis
Uvigerina gardnerae
Bulimina ovata
Robulus inusitatus
Spiroplectammina mississippiensis
Globulina gibba
Guttulina irregularis
Lenticulina convergens
Angulogerina sp. 1
Robulus clericii
Fursenkoina dibollensis
Uvigerina glabrans
Hanzawaia mississippiensis
Stilostomella jacksonensis
Astacolus danvillensis
Marginulina cocoaensis
Stilostomella cocoaensis
Sigmomorphina jacksonensis
Frondicularia tenuissima
Robulus cultratus
R. limbosus
Cancris cocoaensis
Planulina cooperensis
Pseudogaudryina jacksonensis
Karreriella advena
Siphonina danvillensis
Massilina decorata

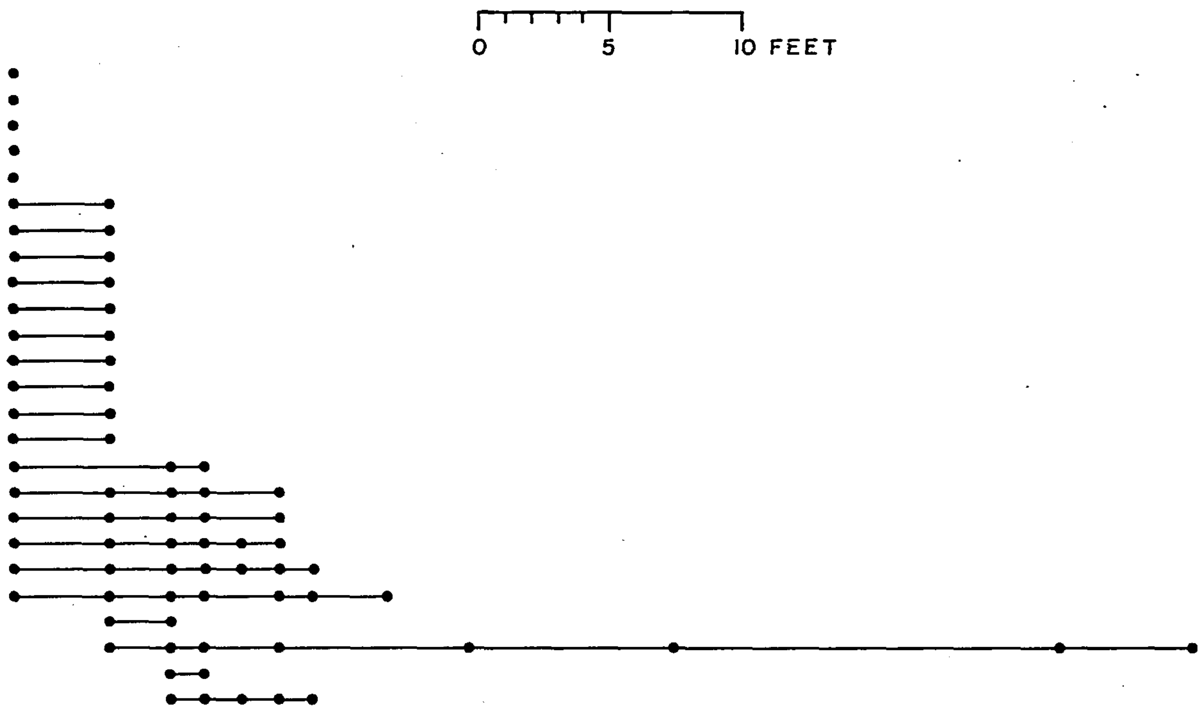


Note: Sample numbers 1-3 pertain to locality 3;
sample numbers 4-9 pertain to locality 2;
sample numbers 10-17 pertain to locality 1.

FIG. 5

Range Chart I-B: Range Chart of Benthonic Foraminifera and Composite Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Wayne and Clarke counties, Mississippi.

Yazoo Clay			Red Bluff Clay		Forest Hill Sand	Marianna Limestone	Formation
Pachuta Marl Member	Shubuta Member						Member
Bluish gray glauconitic sandy marl	Gray sandy marl	Bluish gray clay	Brownish gray clay	Limestone and Marl Gray marl interbedded with four limestone ledges	Brownish black lignitic clay	White limestone	Lithology
13 12	11 10 9 8	7	6	5 4	3	2 1	Sample No.



OSTRACODA

Konarocythere spurgeone
Cytheretta jacksonensis
Bairdoppilata ocalana
Jugosocythereis bicarinata
Paracytheridea belhavenensis
Cytherelloidea cocoaensis
Clithrocytheridea grigsbyi
C. caldwellensis
C. garretti
Cyamocytheridea watervalleyensis
Digmocythere watervalleyensis
N. Gen. n. sp. 1
Loxoconcha creolensis
Echinocythereis jacksonensis
Actinocythereis n. sp. 3
Actinocythereis gibsonensis
"Cythereis" dohmi
Isocythereis couleycreekensis
Haplocytheridea montgomeryensis
Loxoconcha concentrica
Henryhowella florienensis
Occultocythereis broussardi
Digmocythere russelli
Actinocythereis n. sp. 1
Acanthocythereis n. sp. 1

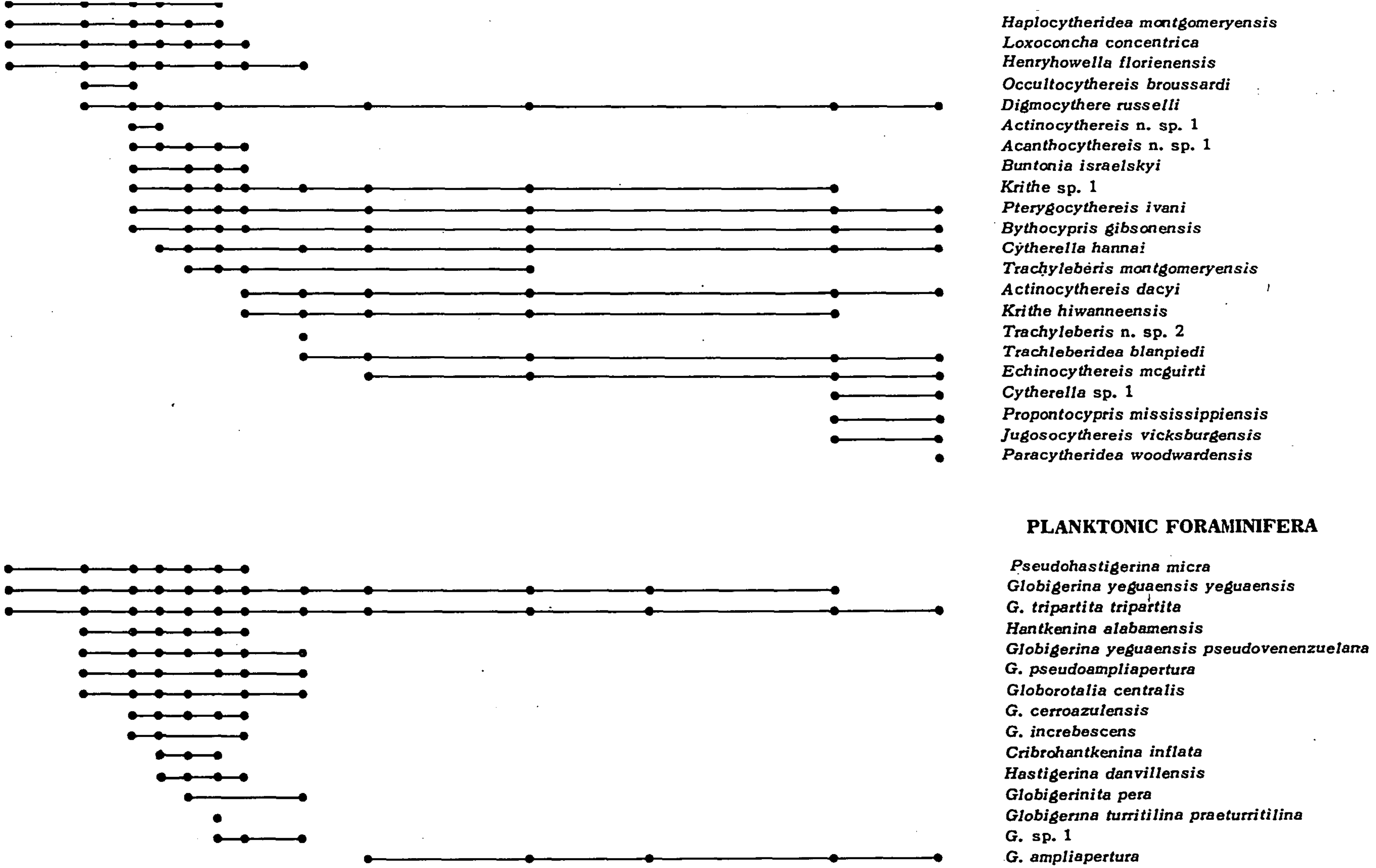
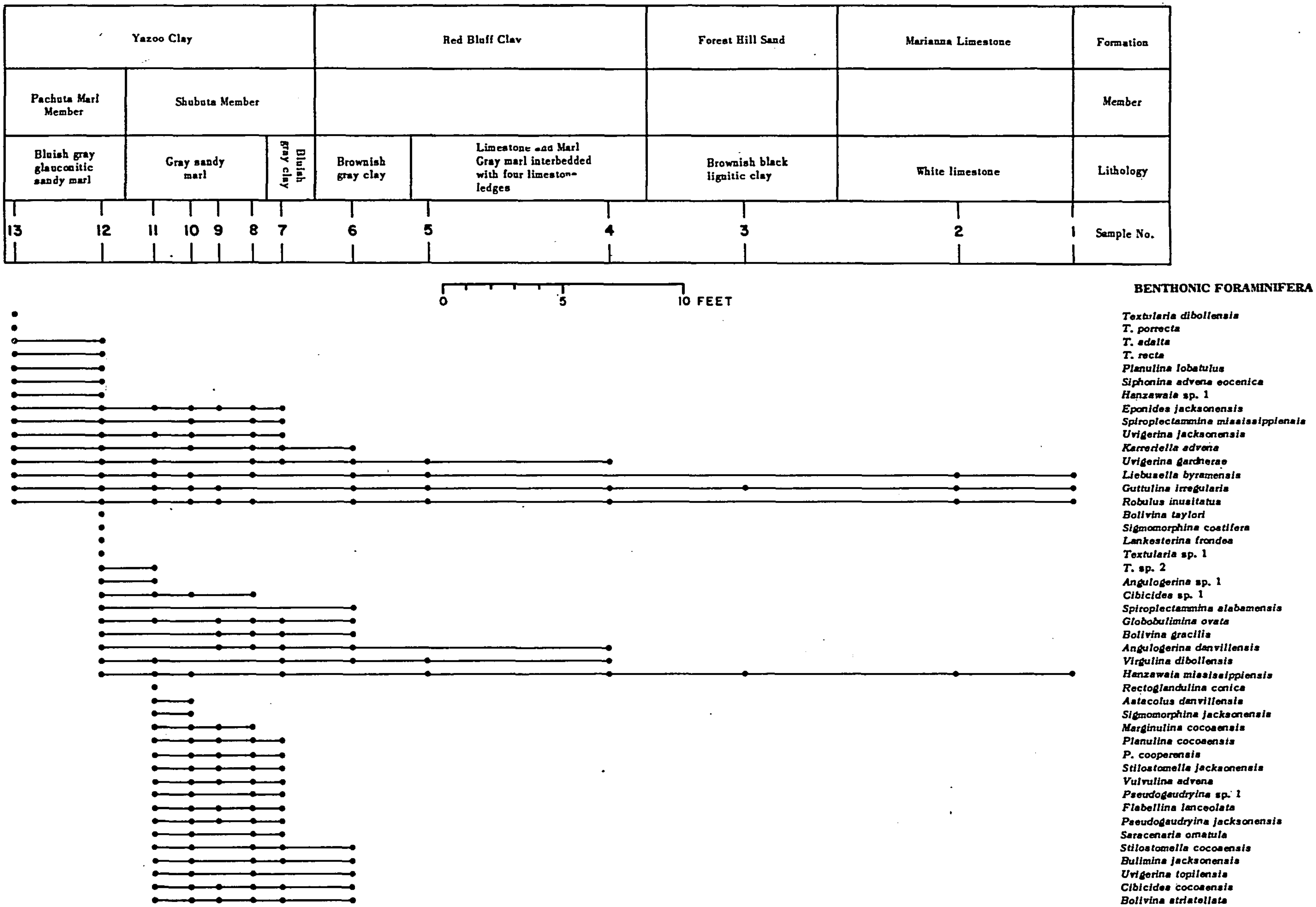


FIG. 6

Range Chart II-A: Range Chart of Ostracoda and Planktonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of St. Stephen's Quarry, Washington County, Alabama.



Yazoo Clay
Red Bluff Clay
Forest Hill Sand
Marianna Limestone
Formation
Pachuta Marl Member
Shubuta Member
Member
Bluish gray glauconitic sandy marl
Gray sandy marl
Bluish gray clay
Brownish gray clay
Limestone and Marl Gray marl interbedded with four limestone ledges
Brownish black lignitic clay
White limestone
Lithology
13 12 11 10 9 8 7 6 5 4 3 2 1
Sample No.
0 5 10 FEET
BENTHONIC FORAMINIFERA
Textularia dibollensis
T. porrecta
T. adalta
T. recta
Planulina lobatulus
Siphonina advena eocenica
Hanzawaia sp. 1
Eponides jacksonensis
Spiroplectammina mississippiensis
Uvigerina jacksonensis
Karreriella advena
Uvigerina gardnerae
Liebusella byramensis
Guttulina irregularis
Robulus inusitatus
Bolivina taylori
Sigmomorphina costifera
Lankesterina frondea
Textularia sp. 1
T. sp. 2
Angulogerina sp. 1
Cibicides sp. 1
Spiroplectammina alabamensis
Globobulimina ovata
Bolivina gracilis
Angulogerina danvillensis
Virgulina dibollensis
Hanzawaia mississippiensis
Rectoglandulina conica
Astacolus danvillensis
Sigmomorphina jacksonensis
Marginulina cocoaensis
Planulina cocoaensis
P. cooperensis
Stilostomella jacksonensis
Vulvulina advena
Pseudogaudryina sp. 1
Flabellina lanceolata
Pseudogaudryina jacksonensis
Saracenaria ornatula
Stilostomella cocoaensis
Bulimina jacksonensis
Uvigerina topilensis
Cibicides cocoaensis
Bolivina striatellata

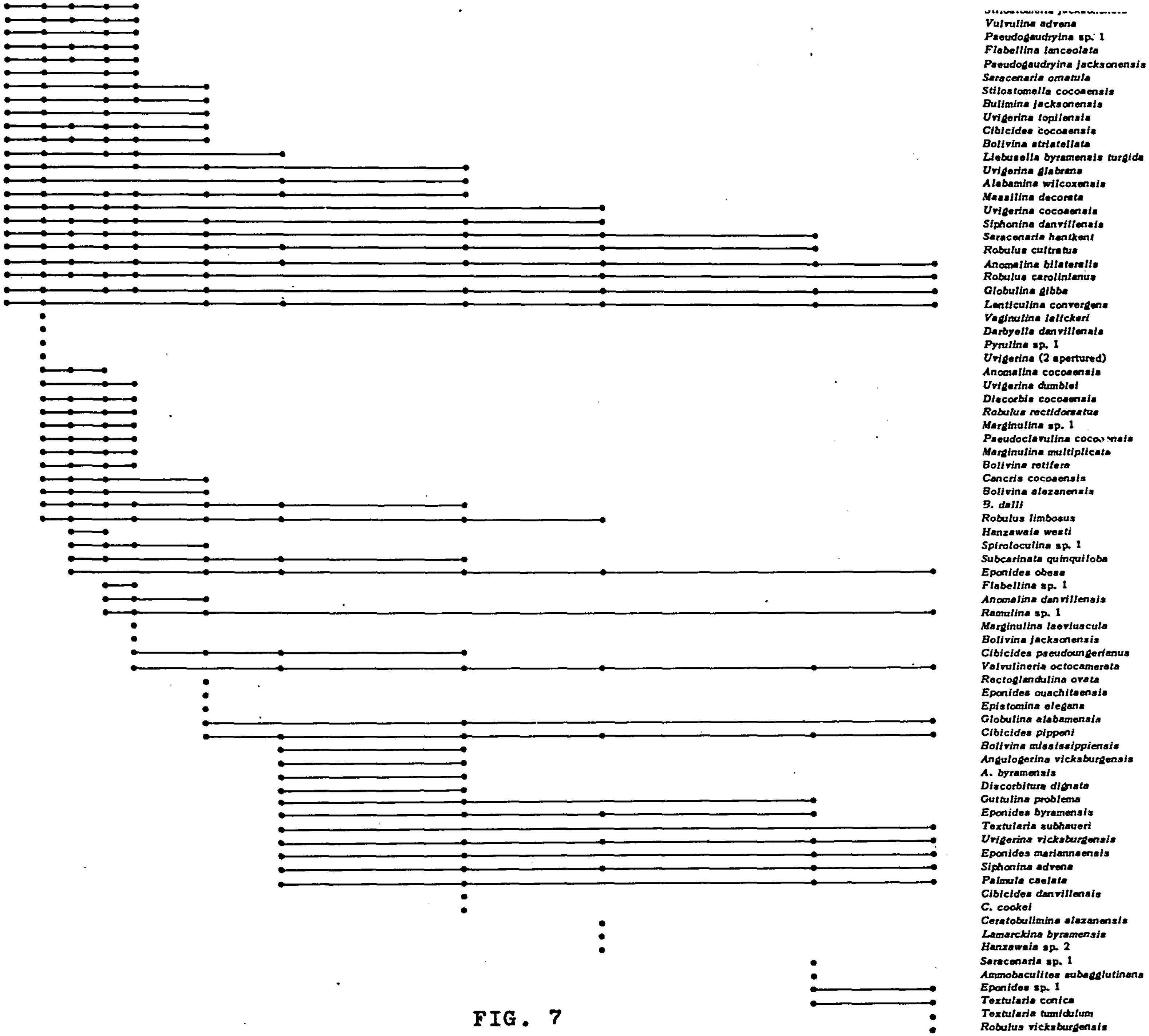
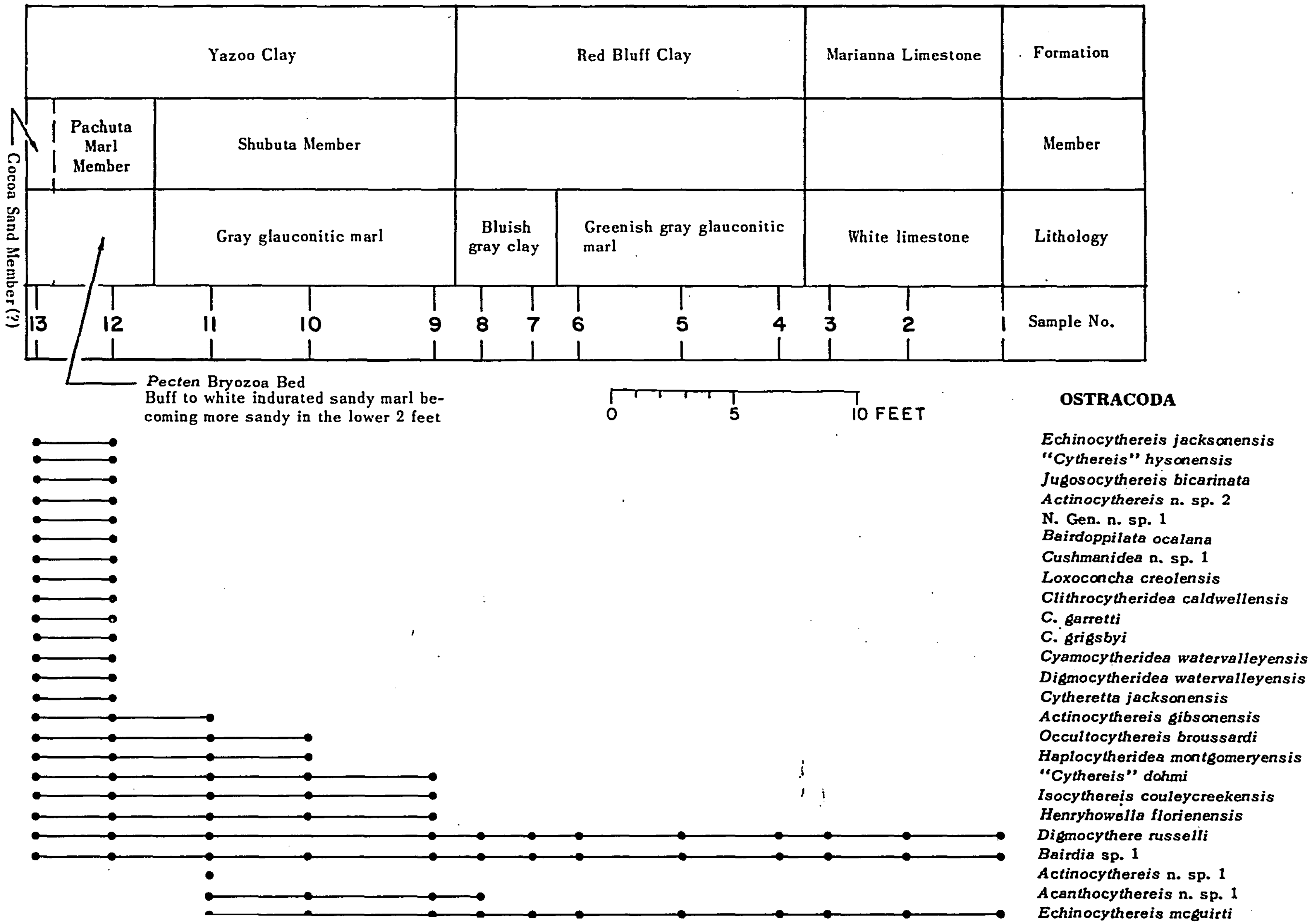


FIG. 7

Range Chart II-B: Range Chart of Benthonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of St. Stephen's Quarry, Washington County, Alabama.


Yazoo Clay
Red Bluff Clay
Marianna Limestone
Formation
Cocoa Sand Member (?)
Pachuta Marl Member
Shubuta Member
Member
Gray glauconitic marl
Bluish gray clay
Greenish gray glauconitic marl
White limestone
Lithology
13
12
11
10
9
8
7
6
5
4
3
2
1
Sample No.
Pecten Bryozoa Bed
Buff to white indurated sandy marl becoming more sandy in the lower 2 feet
0
5
10 FEET
OSTRACODA
Echinocythereis jacksonensis
"Cythereis" hysonensis
Jugosocythereis bicarinata
Actinocythereis n. sp. 2
N. Gen. n. sp. 1
Bairdoppilata ocalana
Cushmanidea n. sp. 1
Loxoconcha creolensis
Clithrocytheridea caldwellensis
C. garretti
C. grigsbyi
Cyamocytheridea watervalleyensis
Digmocytheridea watervalleyensis
Cytheretta jacksonensis
Actinocythereis gibsonensis
Occultocythereis broussardi
Haplocytheridea montgomeryensis
"Cythereis" dohmi
Isocythereis couleycreekensis
Henryhowella florienensis
Digmocythere russelli
Bairdia sp. 1
Actinocythereis n. sp. 1
Acanthocythereis n. sp. 1
Echinocythereis mcguirti

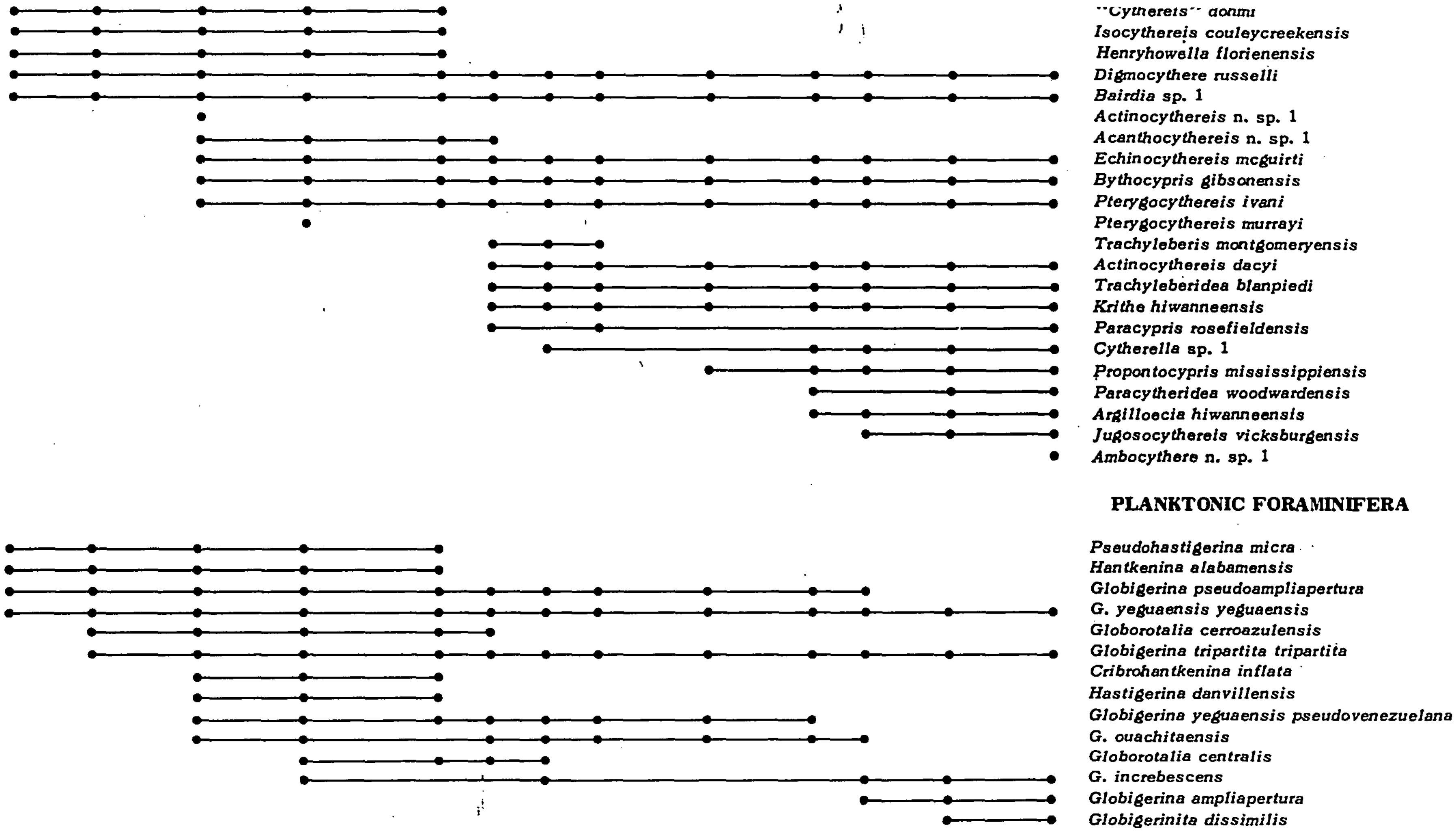
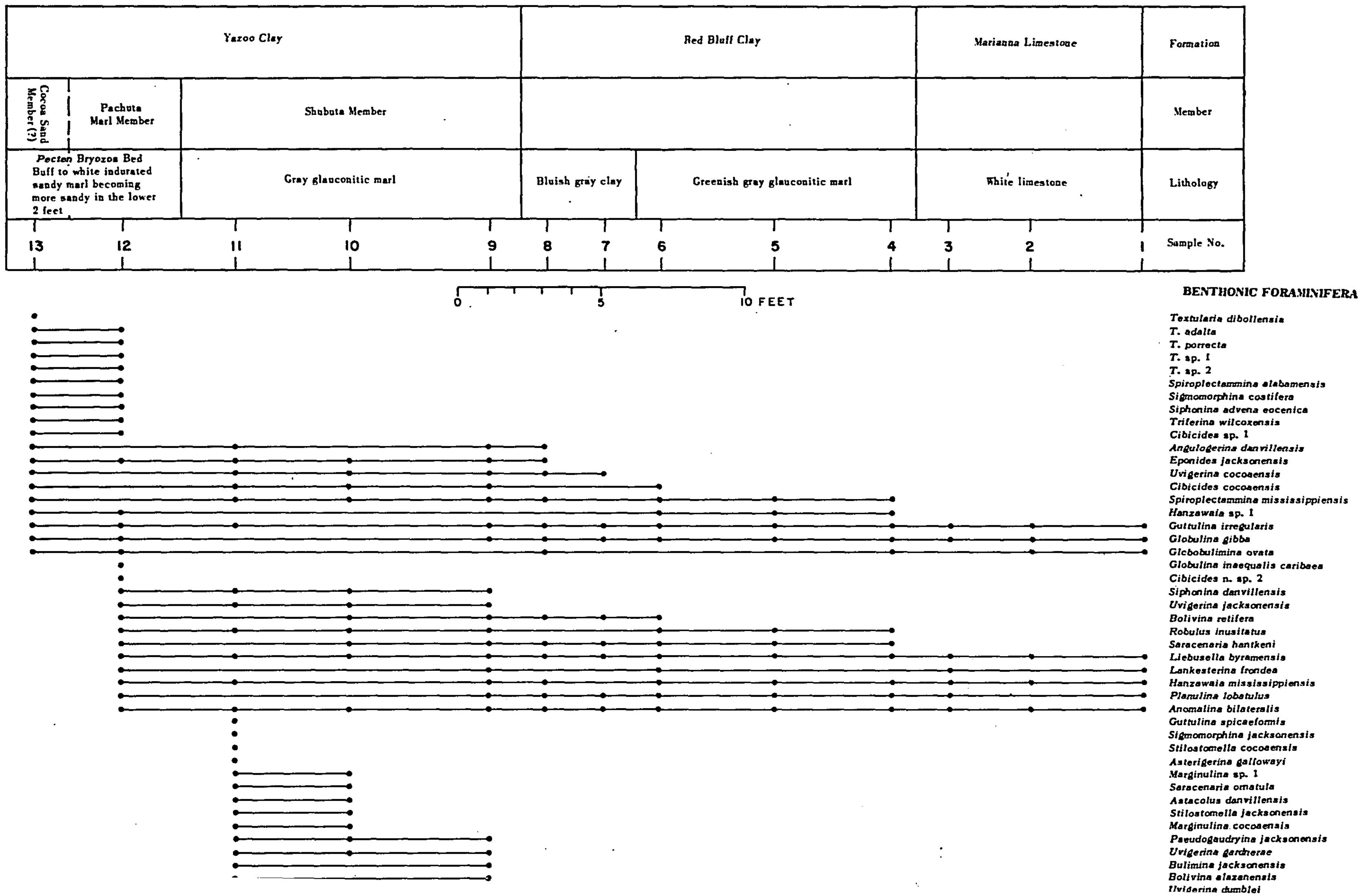


FIG. 8

Range Chart III-A: Range Chart of Ostracoda and Planktonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Little Stave Creek, Clarke County, Alabama.


Yazoo Clay
Red Bluff Clay
Marianna Limestone
Formation
Cocoa Sand Member (?)
Pachuta Marl Member
Shubuta Member
Member
Pecten Bryozoa Bed Buff to white indurated sandy marl becoming more sandy in the lower 2 feet
Gray glauconitic marl
Bluish gray clay
Greenish gray glauconitic marl
White limestone
Lithology
13 12 11 10 9 8 7 6 5 4 3 2 1
Sample No.
0 5 10 FEET
BENTHONIC FORAMINIFERA
Textularia dibollensis
T. adalta
T. porrecta
T. sp. 1
T. sp. 2
Spiroplectammina alabamensis
Sigmomorphina costifera
Siphonina advena eocenica
Triferina wilcoxensis
Cibicides sp. 1
Angulogerina danvillensis
Eponides jacksonensis
Uvigerina cocoaensis
Cibicides cocoaensis
Spiroplectammina mississippiensis
Hanzawaia sp. 1
Guttulina irregularis
Globulina gibba
Globobulimina ovata
Globulina inaequalis caribaea
Cibicides n. sp. 2
Siphonina danvillensis
Uvigerina jacksonensis
Bolivina retifera
Robulus inusitatus
Saracenaria hantkeni
Liebusella byramensis
Lankesterina frondea
Hanzawaia mississippiensis
Planulina lobatulus
Anomalina bilateralis
Guttulina spicaeformis
Sigmomorphina jacksonensis
Stilostomella cocoaensis
Asterigerina gallowayi
Marginulina sp. 1
Saracenaria ornatula
Astacolus danvillensis
Stilostomella jacksonensis
Marginulina cocoaensis
Pseudogaudryina jacksonensis
Uvigerina gardnerae
Bulimina jacksonensis
Bolivina alazanensis
Uvigerina dumblei

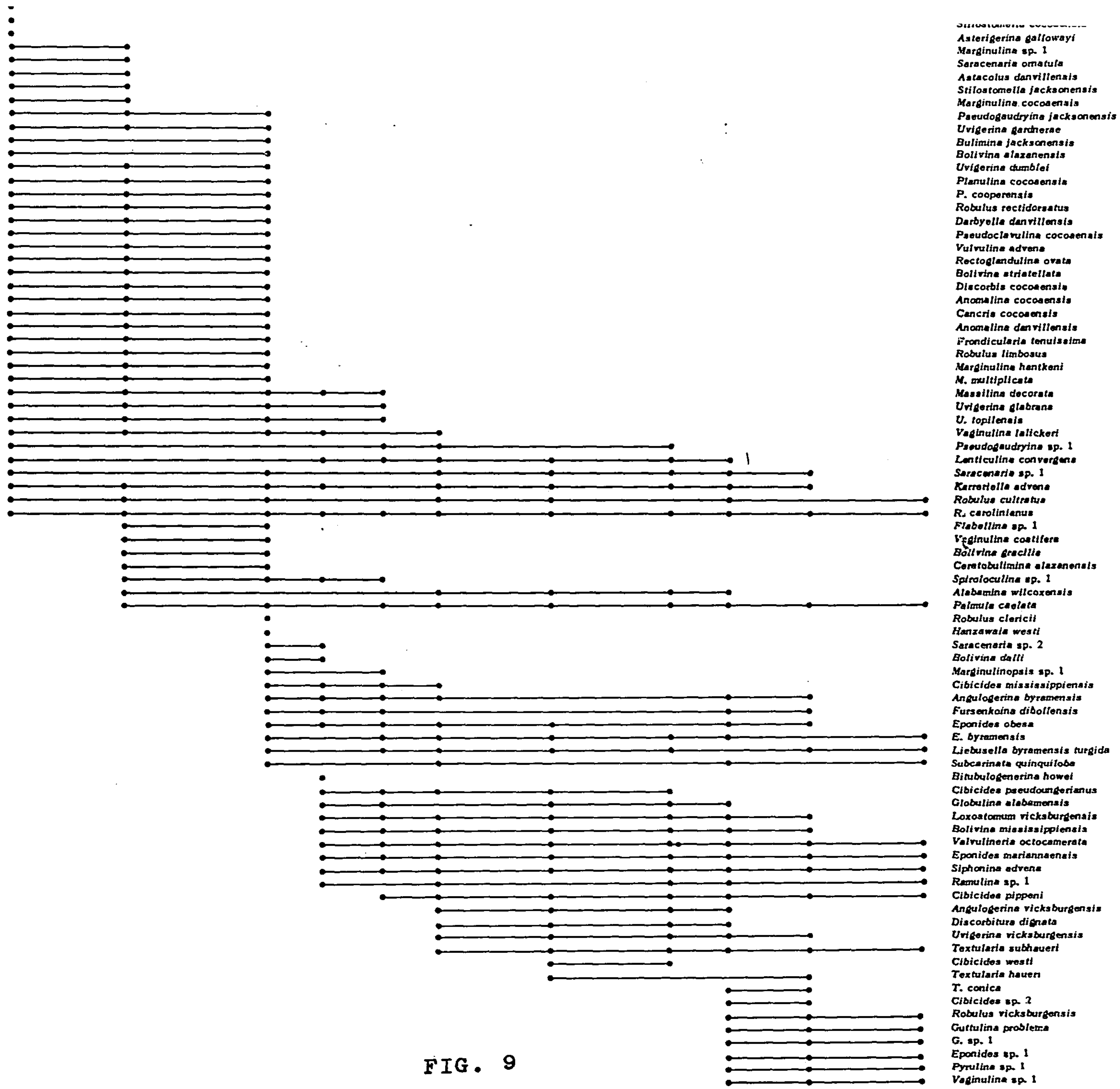
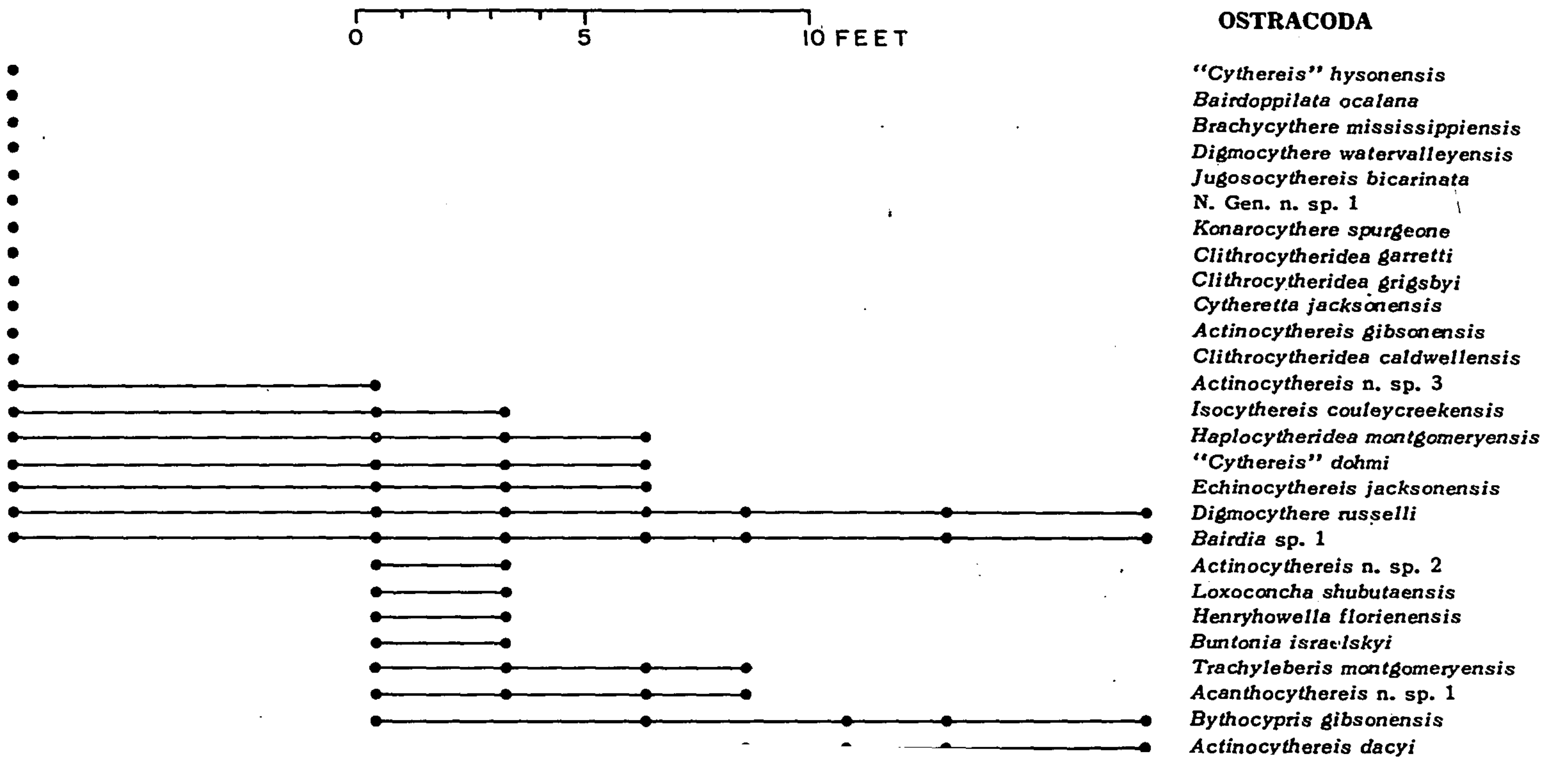


FIG. 9

Range Chart III-B: Range Chart of Benthonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Little Stave Creek, Clarke County, Alabama.

Jackson Group Undifferentiated			Red Bluff Clay	Marianna Limestone	Formation
Hard ledge of white limestone becomes more glauconitic downward	Blue fossiliferous marl	Blue plastic clay	Blue marl	Soft white limestone	Lithology
9	8 7	6 5	4 3	2 1	Sample No.



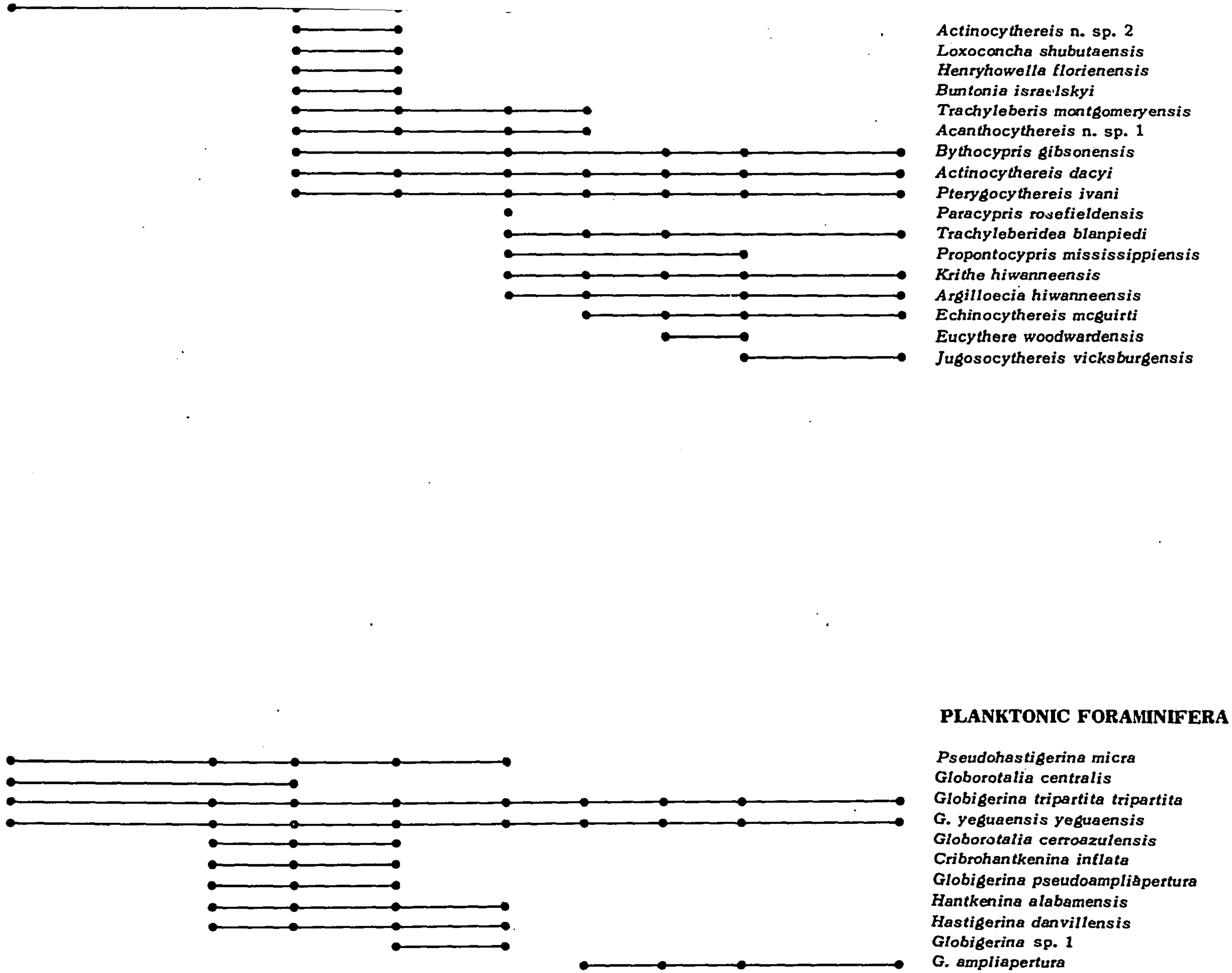
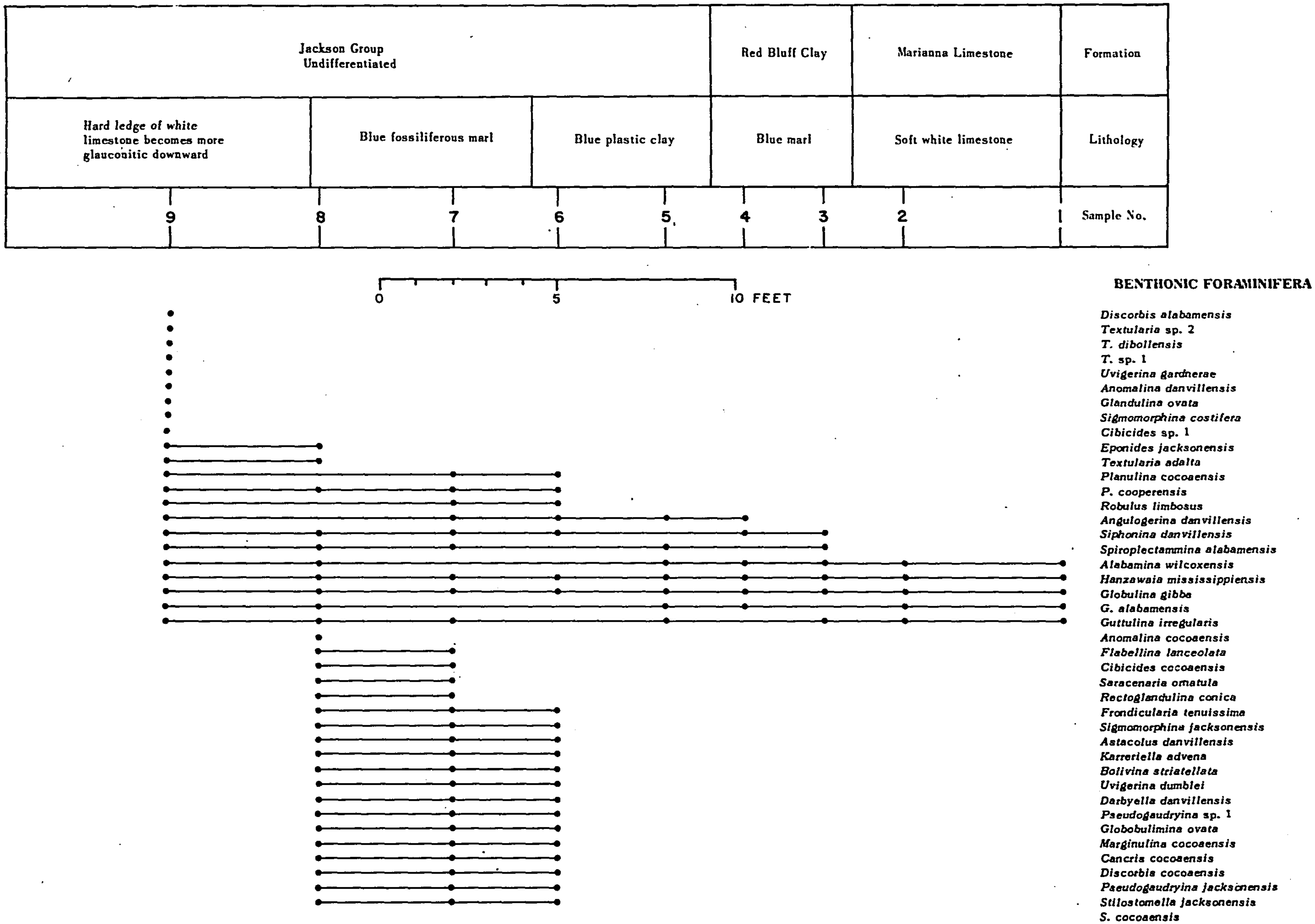


FIG.10

Range Chart IV-A: Range Chart of Ostracoda and Planktonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian 1½ miles north of Jackson, Clarke County, Alabama (Section after Toulmin, 1940, p. 91).


Jackson Group Undifferentiated
Red Bluff Clay
Marianna Limestone
Formation
Hard ledge of white limestone becomes more glauconitic downward
Blue fossiliferous marl
Blue plastic clay
Blue marl
Soft white limestone
Lithology
9
8
7
6
5
4
3
2
1
Sample No.
0
5
10 FEET
BENTHONIC FORAMINIFERA
Discorbis alabamensis
Textularia sp. 2
T. dibollensis
T. sp. 1
Uvigerina gardnerae
Anomalina danvillensis
Glandulina ovata
Sigmomorphina costifera
Cibicides sp. 1
Eponides jacksonensis
Textularia adalta
Planulina cocoaensis
P. cooperensis
Robulus limbosus
Angulogerina danvillensis
Siphonina danvillensis
Spiroplectammina alabamensis
Alabamina wilcoxensis
Hanzawaia mississippiensis
Globulina gibba
G. alabamensis
Guttulina irregularis
Anomalina cocoaensis
Flabellina lanceolata
Cibicides cocoaensis
Saracenaria ornatula
Rectoglandulina conica
Frondicularia tenuissima
Sigmomorphina jacksonensis
Astacolus danvillensis
Karreriella advena
Bolivina striatellata
Uvigerina dumblei
Darbyella danvillensis
Pseudogaudryina sp. 1
Globobulimina ovata
Marginulina cocoaensis
Cancris cocoaensis
Discorbis cocoaensis
Pseudogaudryina jacksonensis
Stilostomella jacksonensis
S. cocoaensis

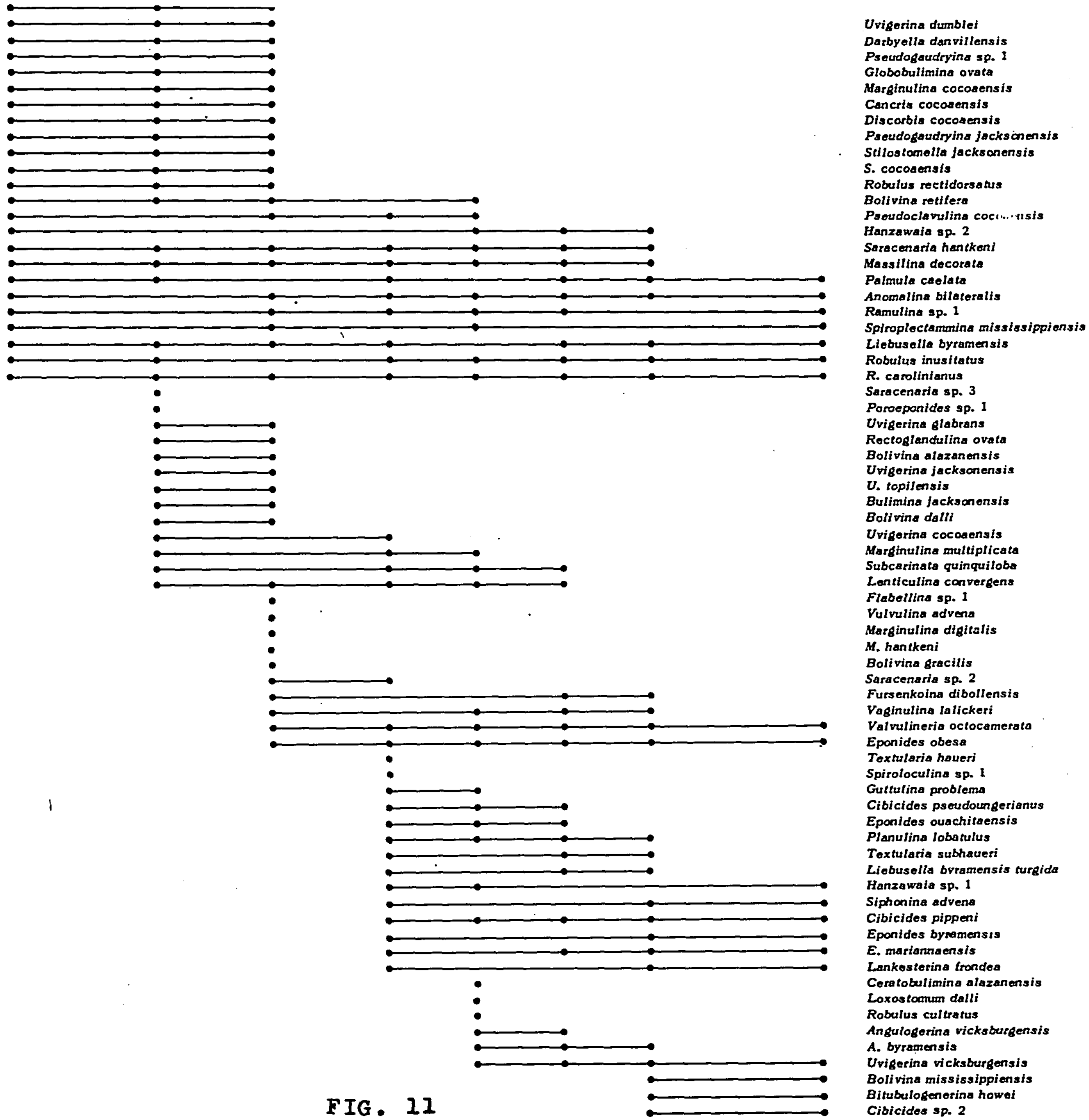
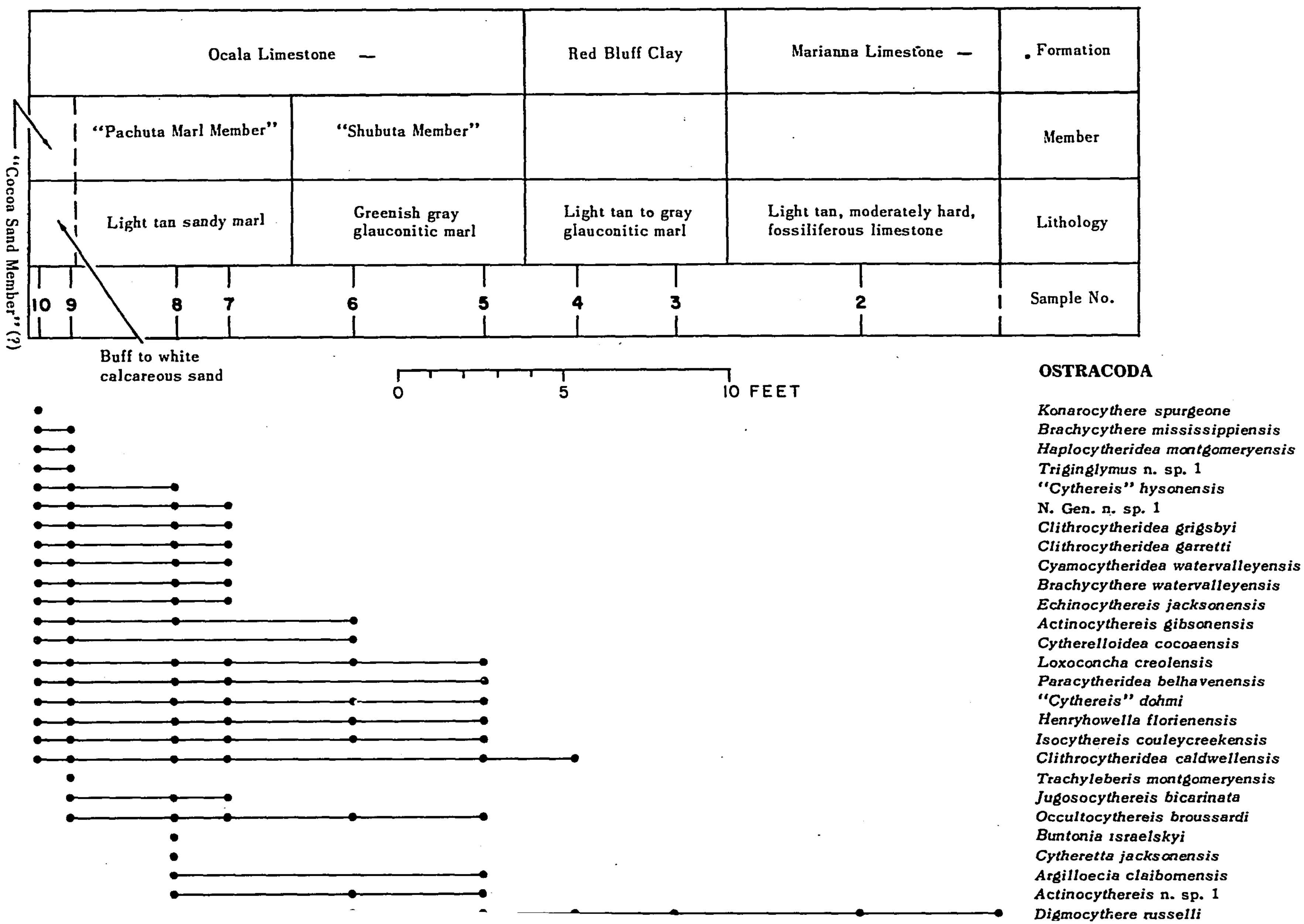
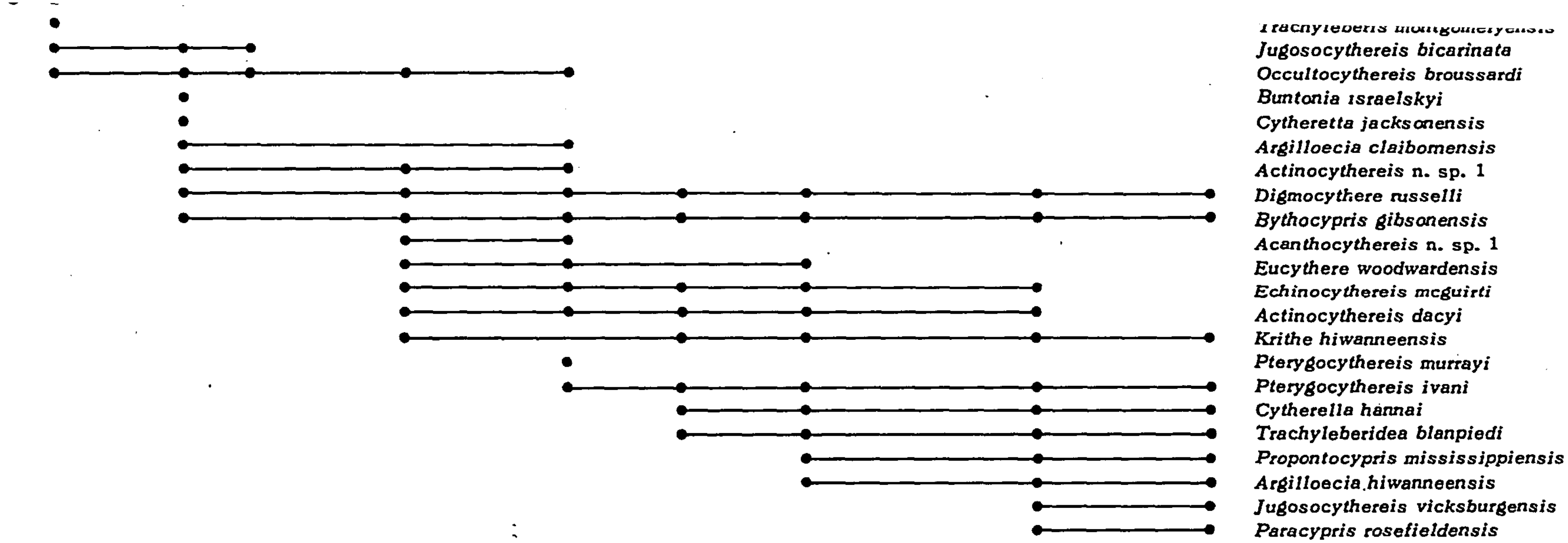


FIG. 11

Range Chart IV-B: Range Chart of Benthonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian 1½ miles north of Jackson Clarke County, Alabama (Section after Toulmin, 1940, p. 91).



Ocala Limestone
Red Bluff Clay
Marianna Limestone
Formation
"Pachuta Marl Member"
"Shubuta Member"
Member
"Cocoa Sand Member" (?)
Light tan sandy marl
Greenish gray glauconitic marl
Light tan to gray glauconitic marl
Light tan, moderately hard, fossiliferous limestone
Lithology
10 9 8 7 6 5 4 3 2 1
Sample No.
Buff to white calcareous sand
0 5 10 FEET
OSTRACODA
Konarocythere spurgeone
Brachycythere mississippiensis
Haplocytheridea montgomeryensis
Triginglymus n. sp. 1
"Cythereis" hysonensis
N. Gen. n. sp. 1
Clithrocytheridea grigsbyi
Clithrocytheridea garretti
Cyamocytheridea watervalleyensis
Brachycythere watervalleyensis
Echinocythereis jacksonensis
Actinocythereis gibsonensis
Cytherelloidea cocoaensis
Loxoconcha creolensis
Paracytheridea belhavenensis
"Cythereis" dohmi
Henryhowella florienensis
Isocythereis couleycreekensis
Clithrocytheridea caldwellensis
Trachyleberis montgomeryensis
Jugosocythereis bicarinata
Occultocythereis broussardi
Buntonia israelskyi
Cytheretta jacksonensis
Argilloecia claibornensis
Actinocythereis n. sp. 1
Digmocythere russelli



This ostracod in formation adapted from R. J. Mullins, M.S. thesis, Lauisiana State University.

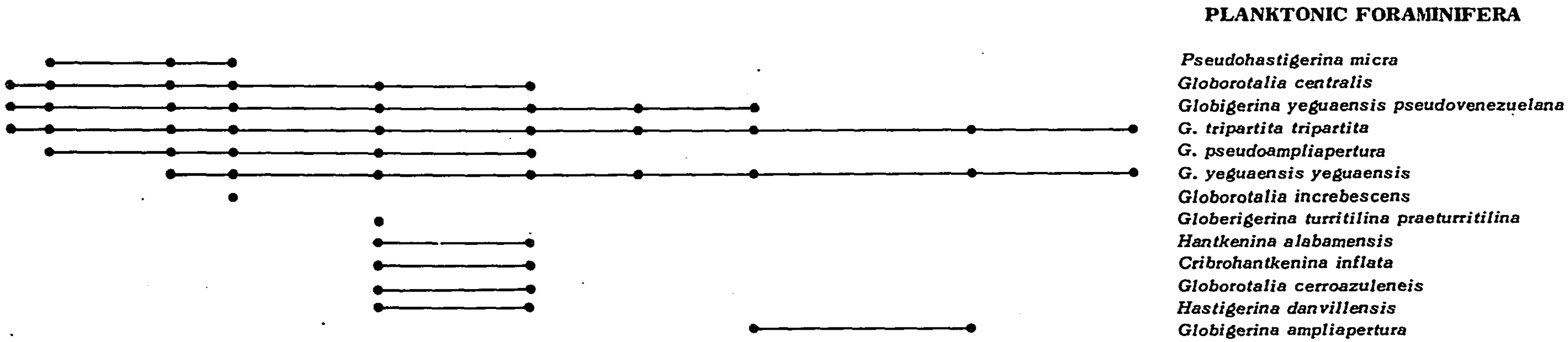
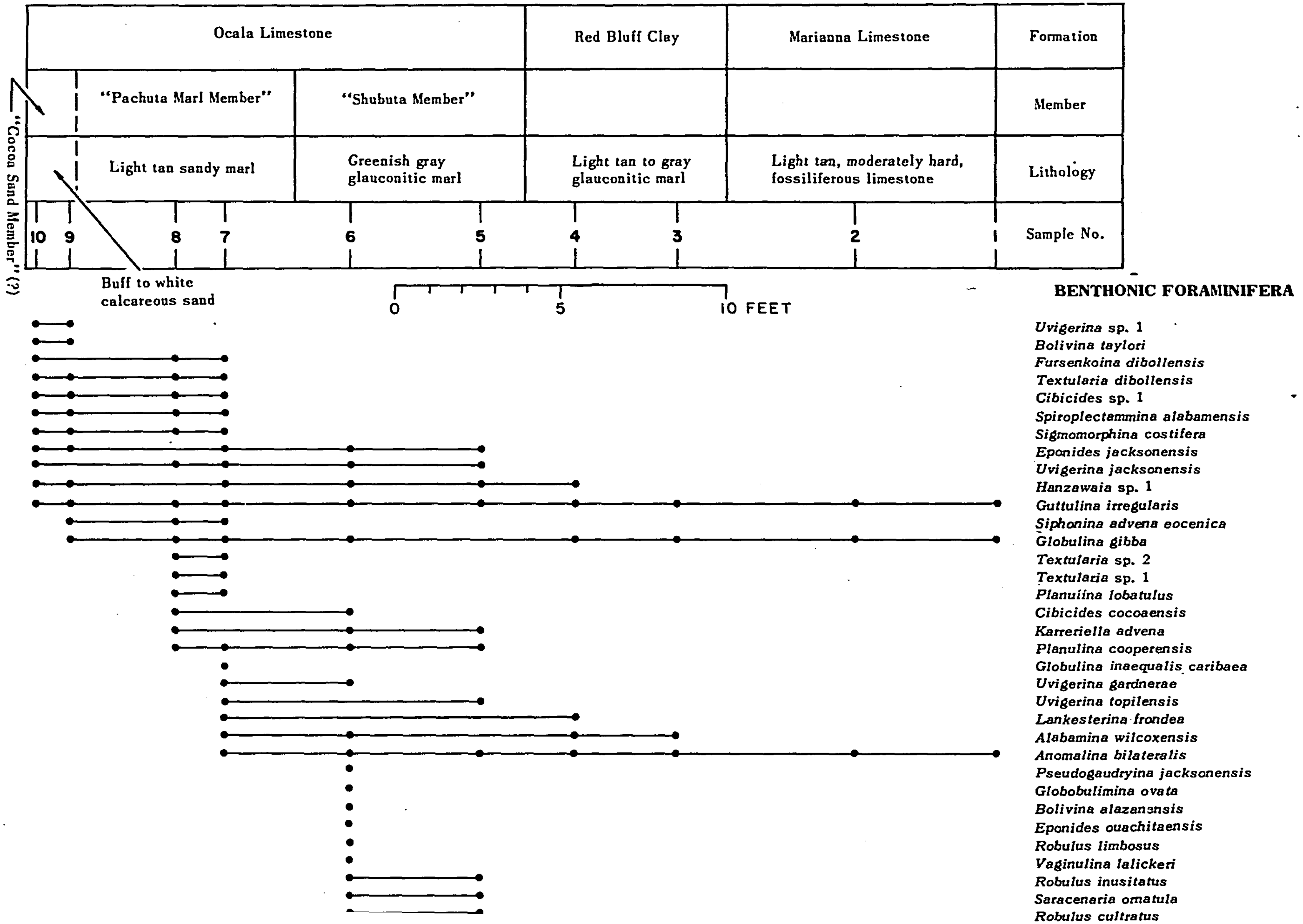


FIG. 12

Range Chart V-A: Range Chart of Ostracoda and Planktonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Perdue Hill, Monroe County, Alabama.


Ocala Limestone
Red Bluff Clay
Marianna Limestone
Formation
"Pachuta Marl Member"
"Shubuta Member"
Member
"Cocoa Sand Member" (?)
Light tan sandy marl
Greenish gray glauconitic marl
Light tan to gray glauconitic marl
Light tan, moderately hard, fossiliferous limestone
Lithology
10 9 8 7 6 5 4 3 2 1
Sample No.
Buff to white calcareous sand
0 5 10 FEET
BENTHONIC FORAMINIFERA
Uvigerina sp. 1
Bolivina taylori
Fursenkoina dibollensis
Textularia dibollensis
Cibicides sp. 1
Spiroplectammina alabamensis
Sigmomorphina costifera
Eponides jacksonensis
Uvigerina jacksonensis
Hanzawaia sp. 1
Guttulina irregularis
Siphonina advena eocenica
Globulina gibba
Textularia sp. 2
Textularia sp. 1
Planulina lobatulus
Cibicides cocoaensis
Karreriella advena
Planulina cooperensis
Globulina inaequalis caribaea
Uvigerina gardnerae
Uvigerina topilensis
Lankesterina frondea
Alabamina wilcoxensis
Anomalina bilateralis
Pseudogaudryina jacksonensis
Globobulimina ovata
Bolivina alazanensis
Eponides ouachitaensis
Robulus limbosus
Vaginulina lalickeri
Robulus inusitatus
Saracenaria ornatula
Robulus cultratus

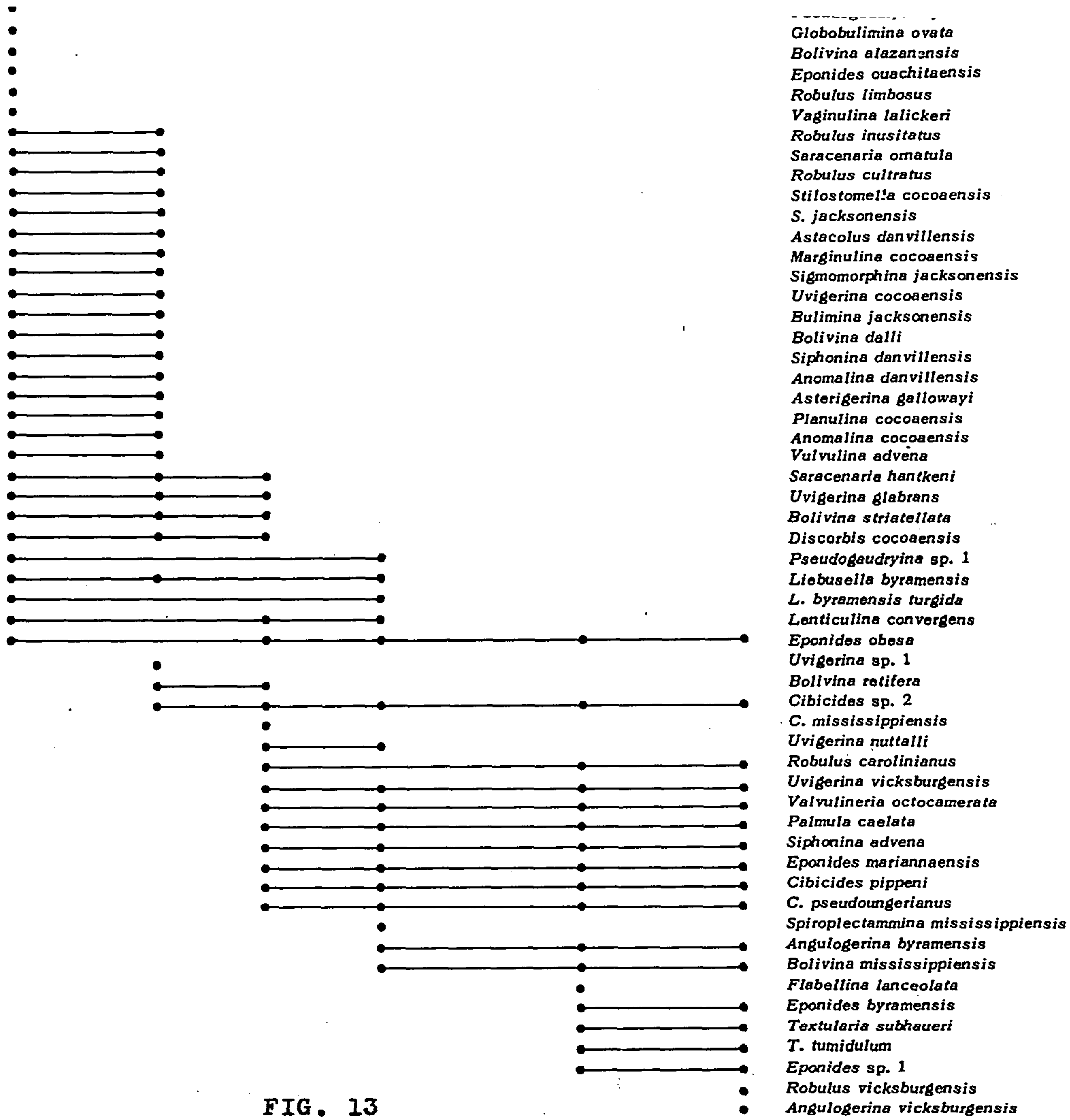


FIG. 13

Range Chart V-B: Range Chart of Benthonic Foraminifera and Geologic Section from the Upper Jacksonian and Lower Vicksburgian of Perdue Hill, Monroe County, Alabama.

The *Spondylus dumosus* zone can be subdivided, at least in the area studied, into a lower *Cribrohantkenina* "*danvillensis*" subzone (Shubuta) and an upper "*Cythereis*" *blanpiedi* subzone (Red Bluff) on the basis of minor faunal variations.

Of the 62 samples used in this study, 53 were collected by the author from surface outcrops and nine were collected and prepared by Dr. H. V. Howe from a section 1 1/2 miles north of Jackson, Alabama.

Disaggregation of the material was accomplished without difficulty, and the microfossils yielded were, without exception, very well preserved.

BIOSTRATIGRAPHY

General Considerations

The establishment of the Jacksonian-Vicksburgian boundary has been recognized as principally a paleontologic problem (Murray and Wilbert, 1950). The problem is not made difficult by scarcity of fossils, for skeletal materials, such as tests of foraminifers, carapaces of ostracods, and hard parts of other marine organisms abound in upper Jacksonian and lower Vicksburgian sediments, at least from Mississippi eastward. Megafossils (molluscs, echinoids, etc.) have been extensively used because they are ordinarily easily identifiable in the field, and usually give a good general idea of stratigraphic position, but their occurrences are too sporadic to establish a precise boundary between biostratigraphic units correlatable over a large region such as the central and eastern Gulf Coast. Some of the more common species which have been used for identifying biostratigraphic units and their formational occurrences are:

Actinocyclina bainbridgensis Vaughan: Pachuta-Cocoa
Chlamys spillmani (Gabb): Pachuta-Cocoa
Clypeaster rogersi (Morton): Marianna
Cylcaster drewryensis Cooke: Red Bluff
Lepidocyclina mantelli (Morton): Marianna
Ostrea vicksburgensis Conrad: Shubuta, Red Bluff, Marianna
Pecten perplanus Morton: Red Bluff
Pecten poulsoni Morton: Marianna
Periarchus lyelli pileussinensis (Ravenel): Pachuta-Cocoa
Spondylus dumosus (Morton): Shubuta, Red Bluff
Terebratulina lachryma (Morton): Shubuta

On the other hand, microfossils, although not identifiable in the field, occur in greater diversity and with greater continuity. The diversity and abundance of ostracods and foraminifers especially provide an excellent opportunity for zonation and correlation of these sediments; however, biostratigraphic procedures become more complex because they are based on assemblages rather than on index or key species.

A biostratigraphic analysis based on only one of the three taxonomic groups used would give results strongly affected by ecologic variations in the sediments. Greatly different taxonomic groups are not likely to be controlled in the same way by ecologic variations. For this reason, three groups, benthonic foraminifers, planktonic foraminifers, and ostracods, were studied separately so that the biostratigraphic data from each would serve as a check on the others. Biostratigraphic boundaries based on these three groups of microfossils are consistent throughout the area under study.

In each of the sections used in this study, the zonal boundaries were established at the major discontinuities shown by each of the faunal groups. Although these were identified visually for planktonic foraminiferal and ostracod data, the benthonic foraminifera are so diversified that successive samples in each section had to be compared by calculating a numerical coefficient of faunal resemblance. Cheetham and Deboo (1963, MS.) have demonstrated the usefulness of Simpson's (1947, 1960) coefficient for identifying faunal discontinuities in one of these sections (St. Stephens quarry). Simpson's coefficient is calculated as $\frac{100\ C}{N1}$, where C represents the number of taxa common to the two faunules being compared and N_1 the number of taxa in the less diversified faunule. The superiority of Simpson's coefficient over more conventional percentage coefficients derives from its minimization of differences in diversity of the faunules being compared and, thus, of ecological differences (Cheetham, 1960). On a purely intuitive basis, and for the purposes of the present problem, coefficients of 70 percent or less are taken to suggest faunal discontinuity, coefficients between 71 and 85 percent to indicate moderate resemblance, and coefficients of 85 percent or more to indicate close resemblance.

Faunal Zones

Floridina antiqua zone.-- The sandy marls and sands (Pachuta and Cocoa) of the upper Jacksonian have been included in an assemblage zone, the *Floridina antiqua* zone, by Cheetham (1959, MS.), on the basis of cheilostome bryozoans. The abundance of bryozoans and *Chlamys spillmani* in beds of this zone accounts for the name "*Pecten*-Bryozoan bed" commonly applied to them (Smith *et al*., 1948).

The top of the *Floridina antiqua* zone is characterized by the last occurrences of *Clithrocytheridea garretti*, *C. grigsbyi*, *Brachycythere* watervalleyensis, "*Cythereis*" *hysonensis*, *Sigmomorphina costifera*, *Textularia dibollensis*, and *T. adalta*.

Species restricted to the *Floridina antiqua* zone are:

Ostracods:
- *Brachycythere mississippiensis* (Meyer)
- *Clithrocytheridea garretti* (Howe & Chambers)
- *C. grigsbyi* (Howe & Chambers)
- *Digmocythere watervalleyensis* (Howe & Chambers)
- *Cyamocytheridea watervalleyensis* (Stephenson)
- "*Cythereis*" *hysonensis* (Howe & Chambers)
- *Konarocythere spurgeonae* (Howe & Chambers)
- *Cytheretta jacksonensis* (Meyer)

Benthonic foraminifers:
- *Sigmomorphina costifera* Cushman
- *Textularia adalta* Cushman
- *T. dibollensis* Cushman & Applin
- *Siphonina advena eocenica* Cushman & Applin

Planktonic foraminifers:
none

Spondylus dumosus zone:-- The body of sediments including the Shubuta, Red Bluff, and Forest Hill Formations contains a distinctive fossil assemblage of megafossils, typified by Spondylus dumosus, and microfossils, including bryozoans, ostracoda, and foraminifers. For this biostratigraphic unit, Cheetham (1957) proposed the name Spondylus dumosus zone. This unit is easily recognizable across the 50-mile line of sections of this study, thinning from nearly 100 feet (mostly clay) in Wayne and Clarke Counties, Mississippi, to about 25 feet (marl and clay) at St. Stephens quarry and Little Stave Creek, Alabama, and to 12 feet (mostly marl) at Perdue Hill, Alabama.

Species restricted to this zone are:

Ostracods:
Acanthocythereis n. sp. 1
Trachyleberis n. sp. 1
Buntonia israelskyi
Buntonia n. sp. 1
Pterygocythereis murrayi Hill

Benthonic foraminifers:
Marginulina cocoaensis Cushman
Vulvulina advena Cushman
Saracenaria ornatula Cushman and Bermudez
Siphonina danvillensis Howe and Wallace
Pseudogaudryina jacksonensis Cushman
Astacolus danvillensis (Howe and Wallace)
Cancris cocoaensis Cushman
Discorbis cocoaensis Cushman and Garrett
Anomalina cocoaensis Cushman
Robulus rectidorsatus Bandy
Pseudoclavulina cocoaensis Cushman

Planktonic foraminifers:
Cribrohantkenina inflata (Howe)
Hastigerina danvillensis (Howe & Wallace)
Globorotalia cocoaensis (Cole)
Globigerina gortanii (Borsetti)
Globigerina pseudoampliapertura Blow & Banner

The ostracod and benthonic foraminiferal fauna of the Spondylus dumosus zone is much more similar to that of the overlying Lepidocyclina mantelli zone than to that of the underlying Floridina antiqua zone (figs. 4-13, 16, 17, 19). The planktonic foraminifers do not exhibit this distributional pattern; instead, the species Cribrohantkenina inflata, Globigerina pseudoampliapertura, Hastigerina danvillensis (figs. 4-13) are introduced at the base and later become extinct within the zone. Thus, their ranges permit subdivision of the Spondylus dumosus zone into two subzones, the Cribrohantkenina "danvillensis" subzone and the "Cythereis" blanpiedi subzone.

The lower division, the Cribrohantkenina danvillensis subzone,[1] contains a foraminiferal and ostracod assemblage that is different, but not distinct, from that of the upper part of the Spondylus dumosus zone (fig. 18, 20). It is not the intention of the writer to relegate the Cribrohantkenina "danvillensis" zone of Eames et al. (1962) to subzonal rank on a world wide basis but the occurrence of the species[2] serves as a useful marker for local biostratigraphic correlation within the Spondylus dumosus zone.

---

[1]The section exposed at St. Stephens quarry from the first to the last occurrence of Cribrohantkenina danvillensis, Globorotalia cocoaensis, Acanthocythereis n. sp. 1, Globorotalia cocoaensis, and Marginulina cocoaensis is designated as the type section for this subzone. Lithologically, this subzone includes the Shubuta sediments consisting of six feet of gray marl overlain by 2 feet of bluish gray clay.

[2]Spraul (1962) in a study of the genus Cribrohantkenina placed all the species described in Cribrohantkenina placed all the species described in Cribrohantkenina inflata. This interpretation seems valid because there is no distributional pattern (stratigraphic or geographic) of morphological differences. This species is referred to as Cribrohantkenina inflata in the text and charts but the original zonal name has been retained to avoid confusion.

This subzone contains the most diversified ostracod and foraminiferal assemblages of any of the biostratigraphic units encountered in the study. It contains a deeper water assemblage than shown by the other units, is bounded by the first and last occurrence of Cribrohantkenina inflata and is characterized by the restricted occurrence of Globorotalia cerroazulensis, Hastigerina danvillensis, Vulvulina advena, Anomalina cocoaensis, Discorbis cocoaensis, Marginulina cocoaensis, Sacraceneria ornatula, Acanthocythereis no. sp. 1, and Buntonia no. sp. 1.

An unusual feature of this subzone is that it includes a horizon containing abnormal foraminiferal forms such as a two-apertured Uvigerina (pl. 11, fig. 15) and a Hantkenina alabamensis with two spines at the base of one chamber and also with bifurcating spines (pl. 5, fig. 5, 8). Another anomalous species is "Darbyella" danvillensis which is probably an abnormal Robulus with the last chamber deviating from the plane of coiling. These forms do not occur sporadically but are commonly present at one horizon across the entire line of sections.

The upper subdivision of the Spondylus dumosus zone, the "Cythereis" blanpiedi[3] subzone, seems to correlate with the lower part of the Globigerina ampliapertura zone of Eames et al. (1962) but, as this

---

[3]The section exposed at St. Stephens quarry from the first occurrence of "Cythereis" blanpiedi, Globigerina ampliapertura, Discorbitura dignata and Eponides mariannaensis to the lowest occurrence of, but not including, Lepidocyclina mantelli is designated as the type section for this subzone. This subzone includes the Red Bluff consisting of 10 feet of interbedded limestones and clays underlain by 4 feet of brownish gray clay.

species is not as abundant and consistent as "Cythereis" blanpiedi[4] in the area studied, and therefore the subzone is named for the latter species.

This subzone is characterized by the first occurrence of "Cythereis" blanpiedi and Globigerina ampliapertura. The species Hantkenina alabamensis has been found in this zone but the poor state of preservation has led the writer to agree with Eames et al. that these specimens have been reworked from the lower deposits.

Species occurring in the "Cythereis" blanpiedi subzone but not in Cribrohantkenina "danvillensis" subzone are:

Ostracods:
"Cythereis" blanpiedi Howe
Echinocythereis mcguirti (Howe)
Propontocypris mississippiensis (Howe & Law)

Benthonic foraminifera:
Bolivina mississippiensis Cushman
Discorbitura dignata Bandy
Angulogerina byramensis (Cushman)
A. vicksburgensis Cushman
Palmula caelata (Bermudez)
Robulus vicksburgensis (Cushman)

Planktonic foraminifers:
Globigerina ampliapertura Bolli

Lepidocyclina mantelli zone.-- The soft white limestones (Marianna) and gray, galuconitic marl (Mint Spring) containing abundant Lepidocyclina mantelli and Pecten poulsoni have yielded a distinctive microfaunal assemblage, so that even though this study has included only

---

[4]This species has been placed in the genus Trachyleberidea Bowen, 1953, (see Systematics) but "Cythereis" blanpiedi Howe has been retained for the subzone because of its more common usage in the Gulf Coast.

the lower 10 - 15 feet of this unit, the writer has recognized it as a discrete biostratigraphic unit for which he here proposes the name Lepidocyclina mantelli[5] zone.

The planktonic foraminifers indicate that this zone is correlative with a part of the Globigerina ampliapertura bearing beds of other parts of the world (Eames et al., 1962), but the exact relation requires further study to be established definitely.

Species restricted to this zone are:

Ostracods:
- Hemicythere kniffeni Howe & Law
- Paracypris rosefieldensis Howe & Law
- Ambocythere n. sp. 1
- Jugosocythereis vicksburgensis (Howe & Law)
- Propontocypris mississippiensis (Howe & Law)

Benthonic foraminifers:
- Textularia tumidulum Cushman
- Textularia conica d'Orbigny
- Cancris n. sp. 1
- Guttulina problema Cushman
- Planorbulina larvata Parker & Jones

Planktonic foraminifers:
- Globigerinita dissimilis (Cushman & Bermudez)

Faunal Analysis

Ostracoda.-- Fifty-nine species of ostracods occur in the sample studied. The most diversified assemblage is in the Spondylus dumosus zone (fig. 15), but the other zones have relatively high diversity also. Coefficients of faunal resemblance show the greatest variation for ostracod data; the upper and middle zones have a resemblance of 71 percent, whereas the middle and lower zones have a

---

[5] The section exposed at St. Stephens quarry from the lowest to the highest occurrence of Lepidocyclina mantelli and Pecten poulsoni is designated as the type section of this zone. Lithologically it includes 60 feet of soft light blue to buff limestone of the Marianna above the dark brown Forest Hill clay and is overlain by the crystalline Glendon limestone.

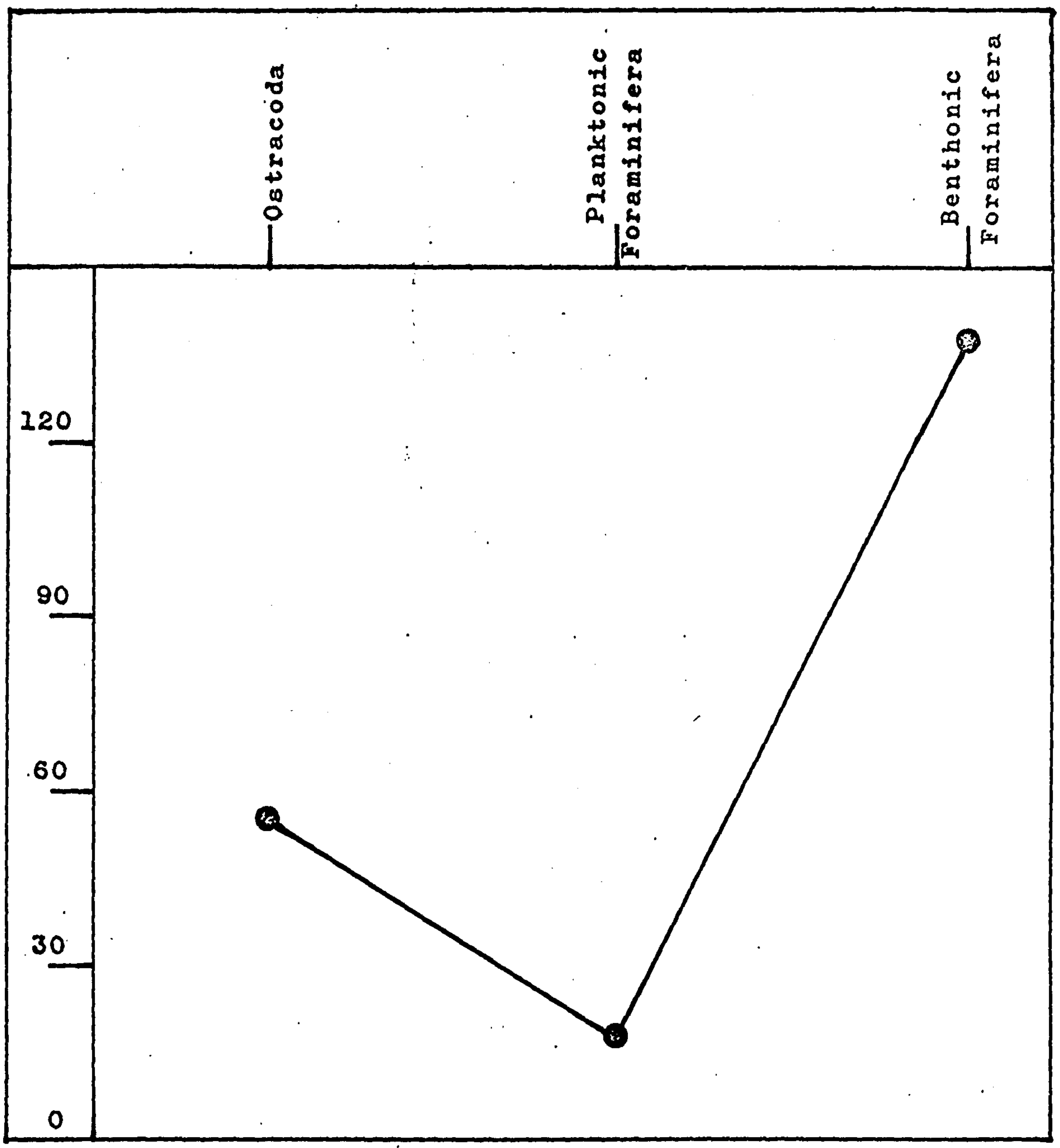


FIG. 14--Diversity of organisms, in number of species, utilized in this study.

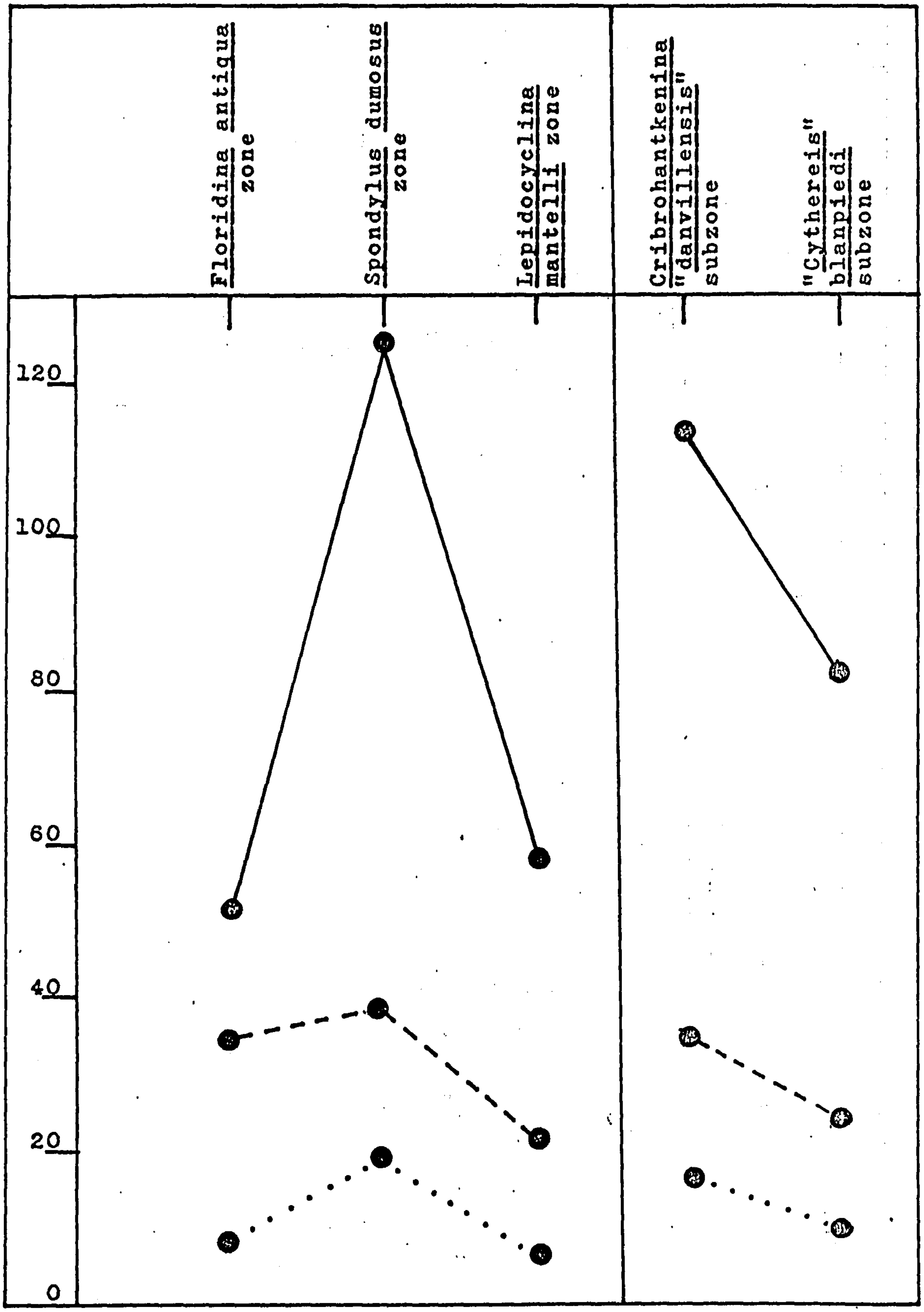


FIG. 15--Diversity of organisms, in number of species, in biostratigraphic units recognized in this study. ----Ostracods, ____ Benthonic foraminifers, ····Planktonic foraminifers.

resemblance of 35 percent.

The most striking change in the ostracod fauna is the extinction of all but three of the eight species of merodont hinged ostracods as the boundary between the *Floridina antiqua* zone and the *Spondylus dumosus* zone is crossed. No such definite change in an important morphologic feature in ostracods occurs at the top of the *Spondylus dumosus* zone.

At the minor discontinuity within the *Spondylus dumosus* zone, five species of related trachyleberids become extinct and are replaced by *Trachyleberidea blanpiedi*.

Planktonic Foraminifera.-- Although the planktonic foraminifers are the least diversified of the groups studied (fig. 14, 15), their mode of life makes them especially significant in inter-provincial correlation. Of the 18 species of planktonic foraminifers encountered, 17 occur in the *Cribrohantkenina* "*danvillensis*" subzone (fig. 15), which must have been deposited in fairly deep water. In the *Lepidocyclina mantelli* and *Floridina antiqua* zones the number of species of planktonic foraminifers is only seven and eight, respectively, and both units probably were deposited in shallower waters.

The coefficients of faunal resemblance are not considered significant in the comparison of the planktonic foraminiferal assemblages between zones because of the small number of species. All the species from the *Floridina antiqua* zone occur in the *Spondylus dumosus* zone. All but one species from the *Lepidocyclina mantelli* zone are present in the zone below. It is felt that the faunal resemblance indices, although recorded (fig. 19), are not reliable for vertical zonation since they are based on the absence or presence of only one species.

Thus, the only faunally distinct unit based on these organisms is the Cribrohantkenina "danvillensis" subzone (fig. 5, 7, 9, 11, 13), the top of which is marked by the last occurrences of Cribrohantkenina inflata, Hantkenina alabamensis, Globorotalia cerroazulensis, Pseudohastigerina micra, and Globorotalia centralis. This assemblage is considered by some stratigraphers (Bolli, Loeblich, Tappan, 1957) to be the top of the Eocene, but Eames et al. (1962) report another Eocene zone, the Globigerina turritilina zone, above this one in the Lindi area, East Africa. Although Eames et al. (1962) feel that this zone is absent in the western hemisphere, the section at Hiawannee, Mississippi, has a five-foot bed at the top of the Cribrohantkenina "danvillensis" subzone containing Globigerina gortanii (figs. 20, 21). It is possible that this is correlative with the East African upper Eocene unit, but it is not considered a distinctive or continuous unit in the area of the present study.

Benthonic Foraminifera.-- This group, with 147 species, is the most diversified (fig. 14), and analysis of range data for the group has required a numerical means of comparing assemblages of vertically successive samples. These are shown for the sections studied in (fig. 20), in which major discontinuities have been identified by coeffcients of 70 percent or less (between the Floridina antiqua and Spondylus dumosus zones) and minor discontinuities by coefficients of 71 to 85 percent (between Cribrohantkenina danvillensis and "Cythereis" blanpiedi subzones, and Spondylus dumosus and Lepidocyclina mantelli zones).

The benthonic foraminiferal assemblage of the Cribrohantkenina "*danvillensis*" subzone was deposited in deeper water than those of any of the other biostratigraphic units studied; calcareous imperforate and agglutinated groups occur only rarely and the Lagenidae and Buliminidae are abundant.

STRATIGRAPHIC IMPLICATIONS OF FAUNAL STUDY

General Remarks

Deposits of Jacksonian and Vicksburgian age have been studied extensively by Gulf Coast stratigraphers, many of whom have given general or detailed accounts of regional and local relationships between time-stratigraphic and lithostratigraphic units (e.g., Murray, 1961; MacNeil, 1944; Cooke, 1926). The purpose of the brief discussion of stratigraphic relationships presented here is not to reiterate previous work, but rather to call attention to the regional and inter-provincial implications of the foregoing faunal analysis.

The stratigraphic nomenclature used herein is summarized in the correlation charts (fig. 2, 3). It is obvious that in a biostratigraphic study such as this units of a purely lithologic connotation, e.g., groups, formations, members, will not necessarily have boundaries coincident or parallel with the biostratigraphic units. On the other hand, inasmuch as paleontologic criteria are the principal basis for establishing time-stratigraphic units, stages should have boundaries coincident with the major discontinuities in the paleontological record. Thus, on the average, boundaries between stages, zones, and subzones form the time-parallel framework within which the lithostratigraphic units lie and on the basis of which the historical interpreation of lithostratigraphy must be made.

Lithostratigraphic Units

Jacksonian and Vicksburgian sediments of the Gulf Coastal Plain extend almost continuously from Florida to Texas in a band roughly parallel to the present coast and consist of diversified rock types with considerable variation in thickness. Murray (1961) and Cooke (1918) reported sections up to 600 feet thick in Texas, Louisiana, and western Mississippi composed almost entirely of sands and clays; sections about 300 feet thick near the Mississippi-Alabama boundary of marls and clays; and sections thicker than 200 feet in eastern Alabama and Florida composed of white limestone.

The commonly recognized subdivision of the Jacksonian and Vicksburgian in the area of study is:

Bucatunna Clay

Byram Marl

Glendon Limestone

Mint Spring Marl* Marianna Limestone*

Forest Hill Formation* Red Bluff Formation*

Shubuta Clay*

Pachuta Marl*

Cocoa Sand*

North Twistwood Creek Clay

Moodys Branch Marl

Only the formations marked (*) were sampled in the present study.

Cocoa sand: This bluish-gray sand with indurated calcareous ledges is about 25-50 feet thick in northeastern Wayne County, Mississippi, and Choctaw County, Alabama. At Shubuta Hill near Shubuta, Mississippi, it is a brown calcareous sand which grades upward into the Pachuta Marl. Eastward, in Clarke County, Alabama, at Little Stave Creek, the Cocoa may be represented by the lower sandier two feet of the "*Pecten*-Bryozoa bed" (Smith, *et al.*, 1948). East of Little Stave Creek, there is no unit having typical Cocoa lithology, and the Pachuta rests directly on North Creek Clay.

Pachuta Marl: The Pachuta is buff to white, sandy, fossiliferous marl varying from five to ten feet thick from the Mississippi-Alabama border to Perdue Hill, Alabama.

Shubuta Clay: This unit consists of 75 feet of light gray-green clay at Shubuta Hill thinning eastward to seven feet of greenish-gray to tan marl at Perdue Hill.

Red Bluff Formation: The Red Bluff consists of 18-20 feet of dark greenish-gray clay at the type locality at Hiwannee, Mississippi. Eastward it thins and changes facies to light gray to buff glauconitic marls, developing hard limestone ledges locally (e. g., St. Stephens quarry).

Forest Hill Formation: The sands and lignitic clays of the Forest Hill Formation interfinger near the Mississippi-Alabama state line with the Red Bluff clays. The Forest Hill sediments encountered in this study consist of ten feet of brown-black lignitic clay at St. Stephen's quarry (fossiliferous) and in Wayne County, Mississippi (unfossiliferous).

Mint Spring Marl: The type section of this unit, at Vicksburg, Mississippi, lies beneath the falls along Mint Spring Bayou. It consists of twelve feet of fossiliferous, bluish-gray, glauconitic marl which thins to two feet in Wayne County, Mississippi (fig. 4, 5), and pinches out farther east. Twenty-five feet of Mint Spring, recognized by Smith *et al.* (1948) at Little Stave Creek, is considered to be Marianna by the writer. In the area of study, the Mint Spring was sampled at only one locality in Wayne County, Mississippi, where it consists of two feet of bluish-gray marl underlying the Marianna.

Marianna Limestone: The soft, light blue to white "Chimney Rock" limestone of the Marianna is remarkably uniform in lithology from Marianna, Florida, to Mississippi. It thickens from approximately 30 feet at Marianna to 60 feet in western Alabama and thins again to 30 feet in eastern Mississippi. Only the lower 10 feet of the Marianna were sampled .

Jacksonian-Vicksburgian Boundary

The position of the Jacksonian-Vicksburgian boundary has been determined heretofore primarily on lithologic evidence. MacNeil (1944) and Murray (1947) considered the Red Bluff-Forest Hill sequence to be between the Jacksonian and the Vicksburgian. Later, Murray (1952) correlated these sediments with the lower part of the Moseley Hill in Louisiana, which he placed in the Vicksburgian. Cooke (1945) and Toulman (1955) recognized the Vicksburgian affinities of the Red Bluff-Forest Hill fauna in Alabama. On the other hand, Moore (1955) considered the Bumpnose Limestone (upper Ocala) of Florida as correlative with the Red Bluff, and by implication placed both in the Jacksonian. Cheetham (1957), on the basis of a cheilostome bryozoan study, concluded that the Red Bluff and the Shubuta belong in a single biostratigraphic unit (Spondylus dumosus zone) having closer affinities with the Vicksburgian than with the Jacksonian and that the boundary between the Eocene and Oligocene in the Eastern Gulf Coast region should be placed at the base of this zone. No worker before Cheetham (1957) had placed the Shubuta in the Oligocene, although Monsour (1937), who referred the Red Bluff to the Oligocene, believed the Shubuta fauna (ostracods and foraminifers)

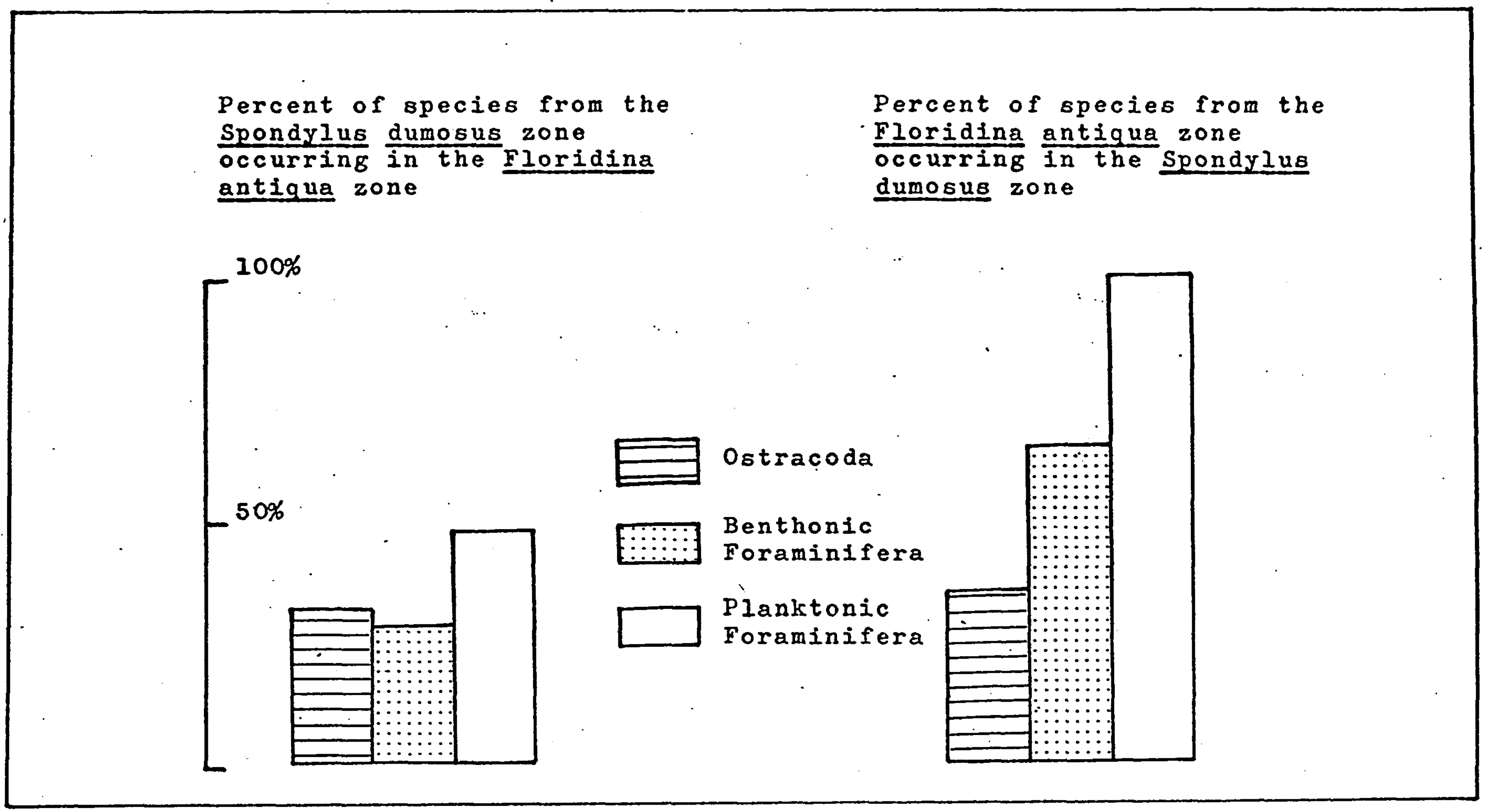


FIG. 16-- Comparison of the *Floridina antiqua* and *Spondylus dumosus* zones using percent occurrences of species.

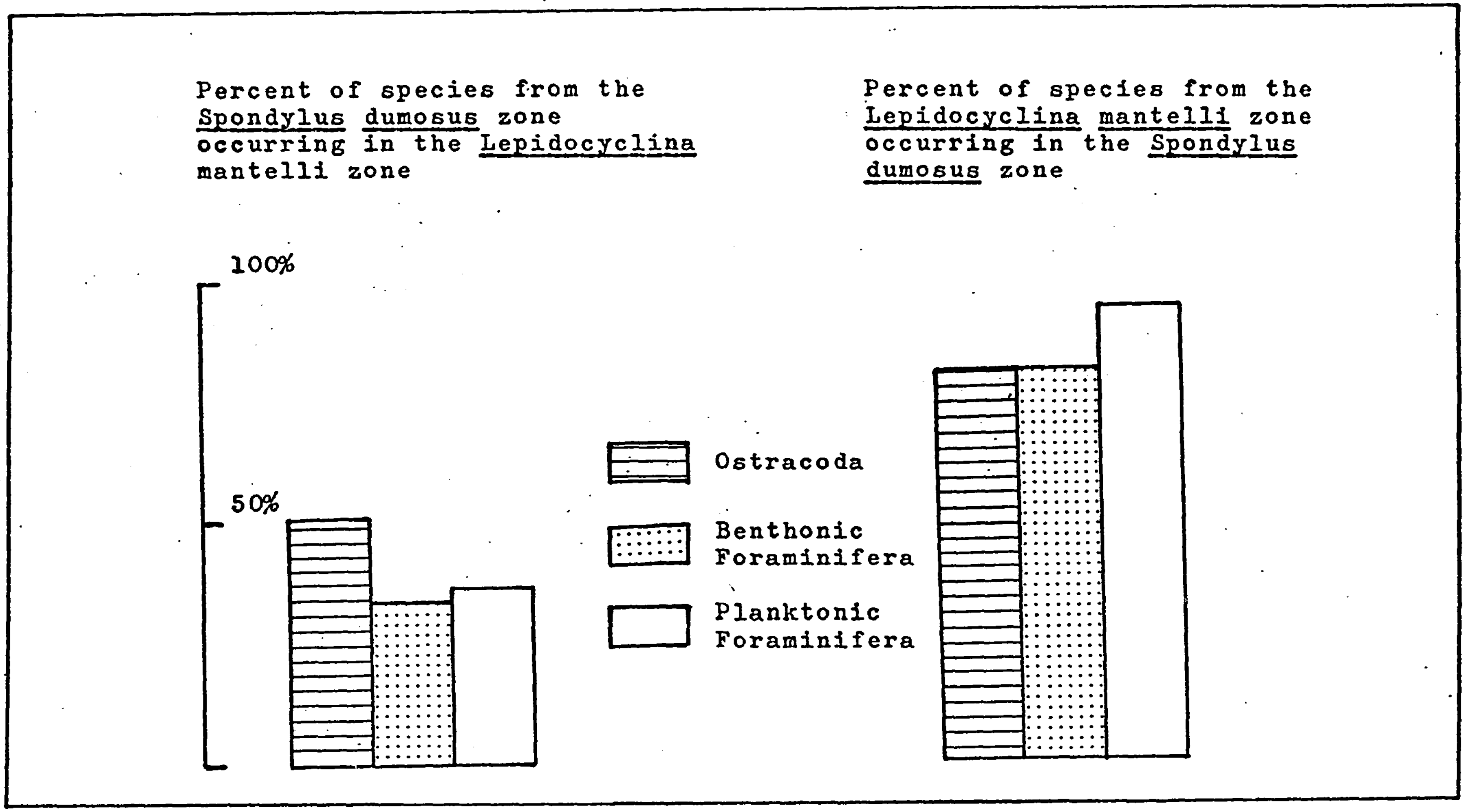


FIG. 17-- Comparison of the *Spondylus dumosus* and *Lepidocyclina mantelli* zones using percent occurrence of species.

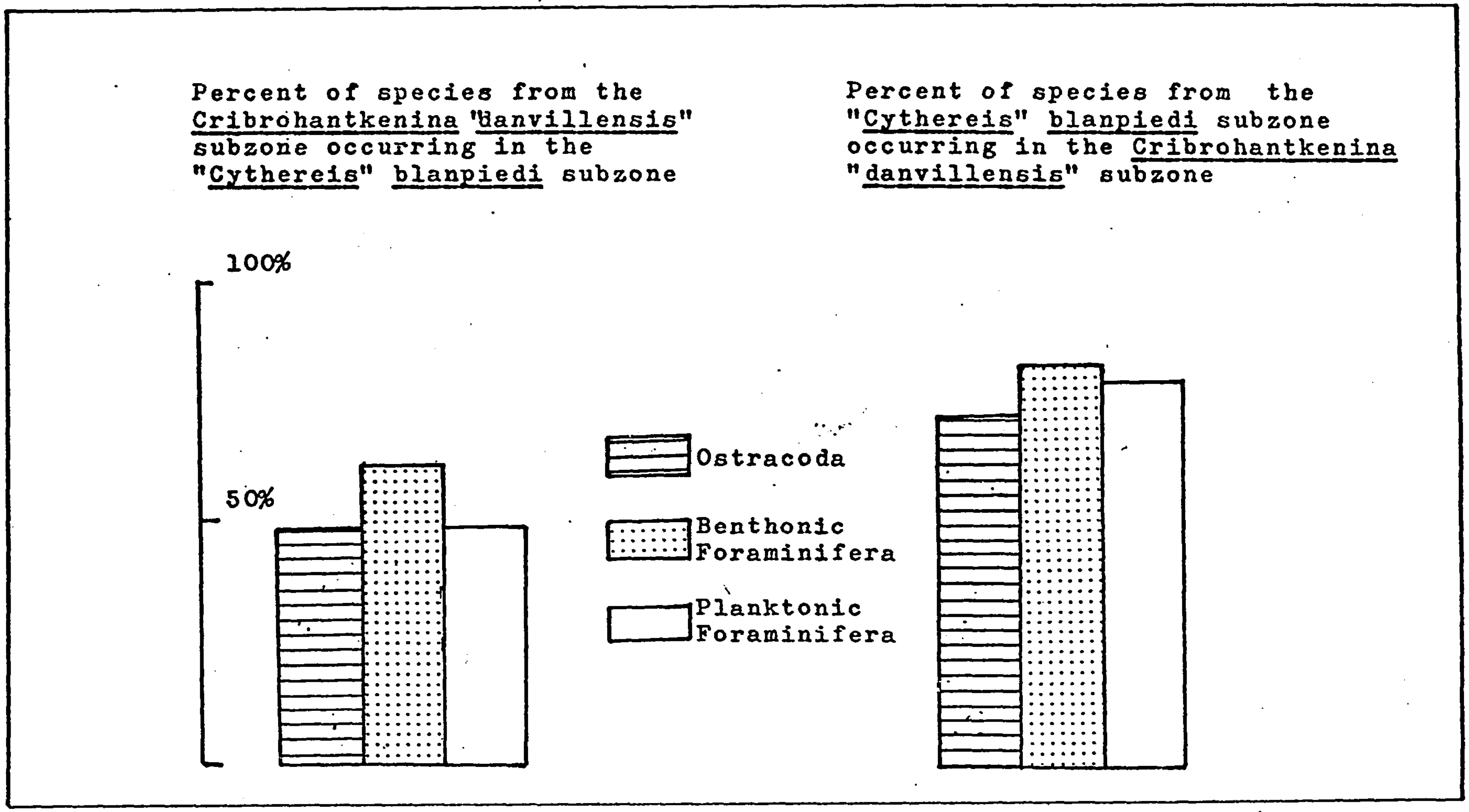


FIG. 18-- Comparison of the *Cribrohantkenina* "*danvillensis*" and "*Cythereis*" *blanpiedi* subzones using percent occurrence of species.

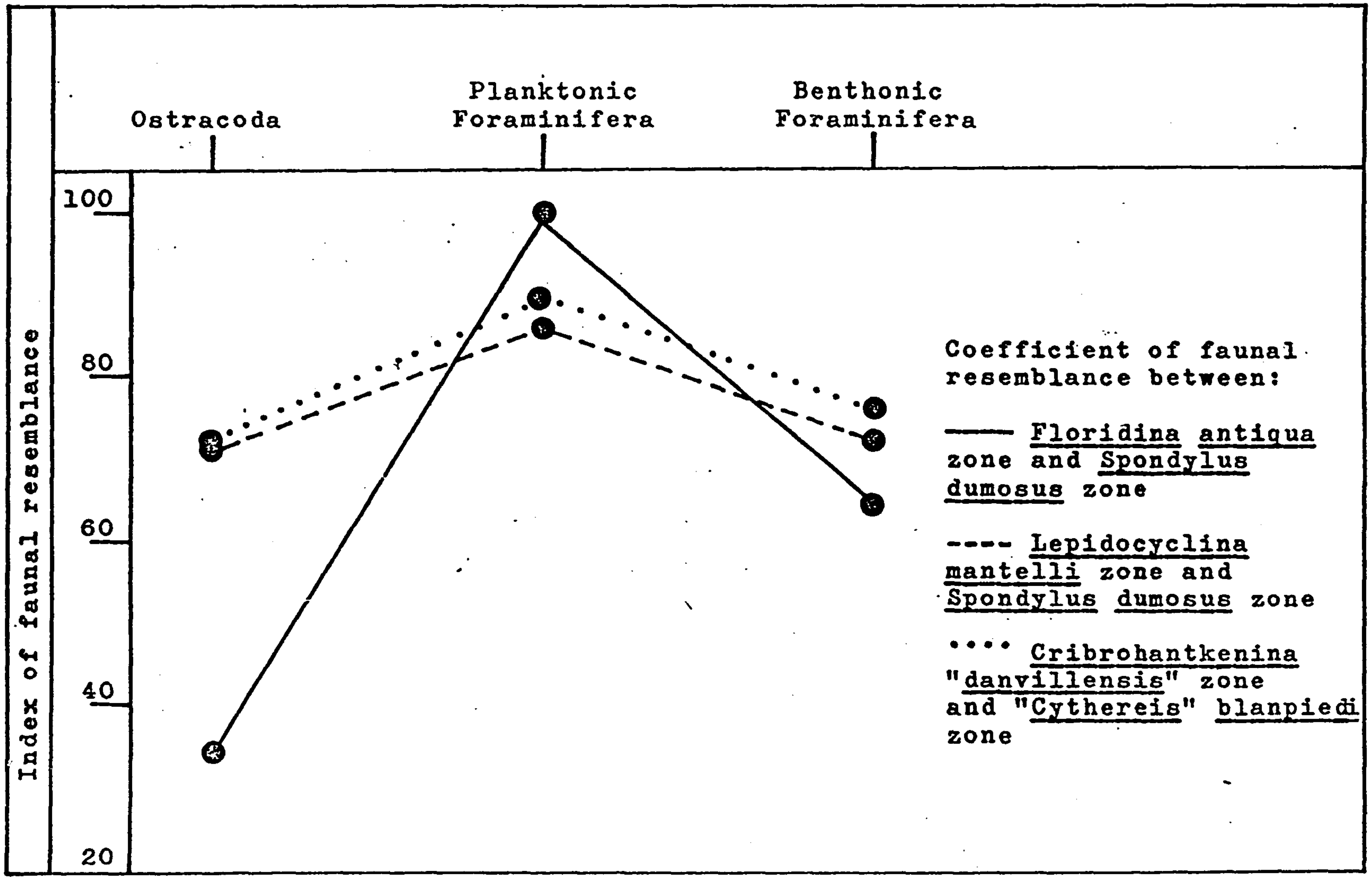


FIG. 19-- Comparison of faunal resemblance between zones and subzones recognized in this study.

Comparison of benthonic foraminiferal assemblages between vertically adjacent samples using Simpson's index of faunal resemblance

Sample number	Section number 1	2	3	4	5
1	89	86	96	100	95
2	87	81	97	90	80
3	79	89	82	100	91
4	92	97	100	91	63
5	100	71	97	67	92
6	85	88	95	91	57
7	76	93	91	92	89
8	*92	98	77	59	84
9	*87	89	92		100
10	86	89	91		
11	88	57	63		
12	94	87	94		
13	83				
14	84				
15	70				
16	87				
17					

Lepidocyclina mantelli zone

"*Cythereis*" *blanpiedi* subzone

Spondylus dumosus zone

Cribrohantkenina "*danvillensis*" subzone

Floridina antiqua zone

* Samples containing <u>Globigerina</u> <u>gortanii</u>

—— Major discontinuity

---- Minor discontinuity

Section 1:- Composite section from Wayne and Clarke Counties, Mississippi
Section 2:- St. Stephens Quarry, Alabama
Section 3:- Little Stave Creek, Alabama
Section 4:- Section 1 and 1/2 miles north of Jackson, Alabama (Toulmin, 1940)
Section 5:- Section 1 and 1/2 miles south of Perdue Hill, Alabama .

FIG. 20-- Faunal resemblance between vertically adjacent samples based on benthonic foraminiferal assemblages.

to be transitional between the typical Jacksonian and the Red Bluff in eastern Mississippi. Murray (1952) also stated that the Shubuta may possibly belong with the Vicksburgian or in a stage between the Jacksonian and the Vicksburgian.

The faunal evidence obtained in the present study (figs. 16-20) lends support to Cheetham's conclusion about the resemblance of the Shubuta-Red Bluff-Forest Hill (Spondylus dumosus zone) fauna to the Vicksburgian Mint Spring-Marianna (Lepidocyclina mantelli zone) fauna. Therefore, the writer proposes to go one step farther by referring the Spondylus dumosus zone to the Vicksburgian Stage. The alternative, erection of a separate stage between Jacksonian and Vicksburgian for the Spondylus dumosus zone, does not seem justified by the degree of faunal difference between the Spondylus dumosus and Lepidocyclina mantelli zones.

Eocene-Oligocene Boundary

Most Gulf Coast stratigraphers have considered the Jacksonian-Vicksburgian boundary to be also the Eocene-Oligocene contact in the southeastern United States (Murray, 1961, Cheetham, 1957, Cooke, 1944). Inasmuch as the Cribrohantkenina inflata-bearing beds, regarded by most micropaleontologists as upper Eocene, lie above the major discontinuity here considered the Jacksonian-Vicksburgian contact, the two horizons do not appear to be coincident. In other words, the provincial time-stratigraphic units, Jacksonian and Vicksburgian Stages, are not separated by the same boundary as the world-wide time-stratigraphic units, Eocene and Oligocene Series. The lower subdivision of the Vicksburgian, the Spondylus dumosus zone, straddles the Eocene-Oligocene boundary, rather than lying above it as suggested by Cheetham (1957). Moreover,

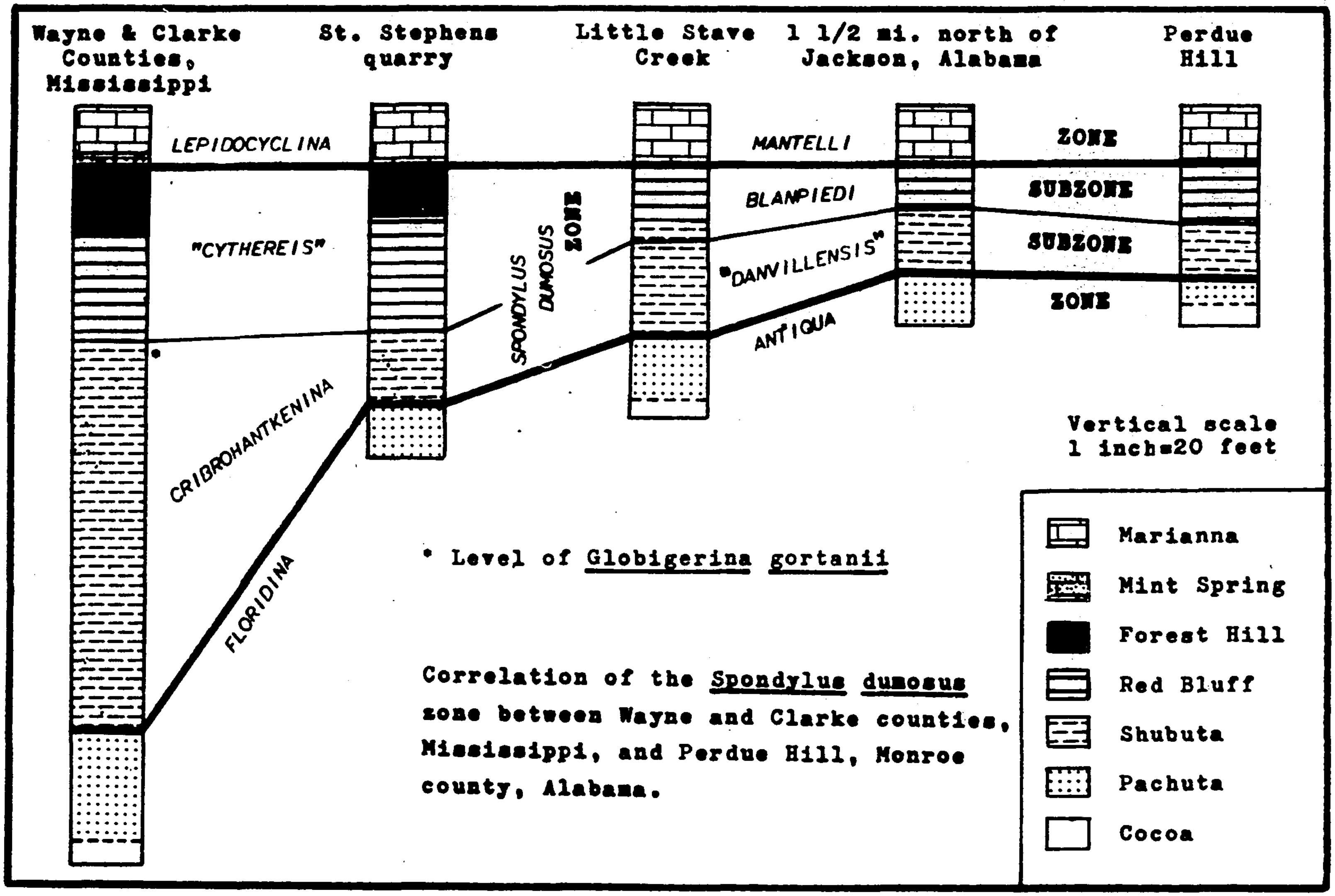


FIG. 21-- Biostratigraphic cross-section of the Jacksonian and Vicksburgian sediments as determined in this present study.

inasmuch as the upper Eocene part of the *Spondylus dumosus* zone (the *Cribrohantkenina* "*danvillensis*" subzone) passes upward through the "*Cythereis*" *blanpiedi* subzone into the *Lepidocyclina mantelli* zone (considered by Eames, *et al*.,1962, to be lower Miocene) without major faunal discontinuity, the hypothesis that there are no sediments of Oligocene age in the Gulf Coast (Eames *et al*., 1962) appears invalid.

SYSTEMATICS

Because of the extremely large number of species and genera in the Jacksonian-Vicksburgian deposits of eastern Mississippi and western Alabama, only those whose nomenclature has not been, or is not, clear are included in the following discussion. No new taxa are named, and neither new nor old taxa are described. Complete taxonomic report on this fauna must await more detailed morphologic study than was possible in the context of this primarily biostratigraphic analysis.

Phylum ARTHROPODA Siebold & Stannius

Class CRUSTACEA Pennant

Subclass OSTRACODA Latreille

Order PODOCOPIDA MUELLER

Family TRACHYLEBERIDIDAE Sylvester-Bradley

Genus HENRYHOWELLA Puri

Henryhowella florienensis (Howe and Chambers)

Pl. 3, fig. 8, 9, 11, and 12

Cythereis florienensis Howe and Chambers, 1935, La. Geol. Surv. Bull., no. 5, pl. 6, figs. 14, 15.

Cythereis deusseni Howe and Chambers, 1935, La. Geol. Surv. Bull. no. 5, p. 27, pl. 1, fig. 15; pl. 6, figs. 2, 3.

Henryhowella florienensis (Howe and Chambers). Krutak, 1961, Jour. Paleo., vol. 35, no. 4, p. 784, pl. 91, fig. 8.

Remarks. The two distinct rows of spines extending posteriorly from the center of the lateral surface characteristic of the type species, *Henryhowella evax* (Canu and Bassler) 1904, are not distinctly evident in well-preserved specimens of *Henryhowella florienensis* but are shown by slightly worn specimens (pl. 9, figs. 8, 9). *Henryhowella* *floriensis* is smaller and its posterior not as broadly rounded as *H. evax*.

Genus ACANTHOCYTHEREIS Howe

Acanthocythereis n. sp. 1

Pl. 4, fig. 14, 17

Remarks: This species shows distinct morphologic affinities with *Henryhowella florienensis* but none of the specimens examined show two rows of spines on the lateral surface, a generic trait of *Henryhowella*. Also, this species is larger, has a more rounded posterior, and shows stronger sexual dimorphism than *H. florienensis*. It is restricted to the *Spondylus dumosus* zone whereas *H. florienensis* extends from the lower *Floridina antiqua* zone into the *Spondylus dumosus* zone.

Genus ISOCYTHEREIS Triebel

Isocythereis couleycreekensis (Gooch)

Pl. 3, fig. 7

Cythereis couleycreekensis Gooch, 1939, Jour. Paleo., vol. 13, p. 584, pl. 67, fig. 1, 2, 3, 8.

Remarks: "*Cythereis*" *couleycreekensis* Gooch is closely related to "*Cythereis*" *aranea* Jones and Sherborn. The median ridge, angling towards the postero-dorsal angle and ending in a low muscle node slightly in front of the center, is very similar to that of "*Cythereis*" *aranea*. The shape in lateral view of the two species is also very similar. Bowen (1953) placed "*C.*" *aranea* in the genus *Trachyleberidea* Bowen, 1953, but recent research by Hazel (L.S.U. dissertation, 1963) suggests that "*Cythereis*" *aranea* and related species belong in the genus *Isocythereis Triebel*, 1940.

Genus TRACHYLEBERIDEA Bowen

Trachyleberidea blanpiedi (Howe)

Pl. 3, fig. 10, 13

Cythereis blanpiedi melvinensis Howe, Howe and Law., 1936, La. Geol. Surv. Bull. 7, p. 4, pl. 5, fig. 22.
Cythereis blanpiedi Howe, Howe and Law, 1936, La. Geol. Surv. Bull. 7, pl. 4, fig. 27; pl. 5, fig. 8.

Remarks: "_Cythereis_" _blanpiedi_ Howe is very closely related to _Cythereis prestwichiana_ Jones and Sherborn, the type species of which was placed in the genus _Trachyleberidea_ Bowen. The angulate posterior, the pronounced muscle node, the denticulations within the reticulations, and a ridge extending from the postero-ventral angle around the anterior and ending near the middle of the dorsal part of the lateral surface suggest that this species is related to "_Cythereis_" _prestwichiana_ and, thus, should belong in the genus _Trachyleberidea_.[1]

Phylum PROTOZOA

Class RHIZOPODA von Siebold

Order FORAMINIFERA d'Orbigny

Superfamily FLOBIGERINACEAE Carpenter

Family HANTKENINIDAE Cushman

Genus CRIBROHANTKENINA Thalman

Cribrohantkenina inflata (Howe)

Pl. 5, fig. 4, 6

Hantkenina inflata Howe, 1938, Jour. Paleo., vol. 2, pp. 13, 14, fig. 2.
Hantkenina mccordi Howe and Wallace, 1932, La. Geol. Surv. Bull. no. 2, pp. 55, 56, figs. 1a, b.

---

[1]The information on the genera _Trachyleberidea_ and _Isocythereis_ was obtained from Joseph E. Hazel (Ph.D. dissertation, Louisiana State University.

Hantkenina danvillensis Howe and Wallace, 1934, Jour. Paleo., vol. 8, no. 1, pp. 35-37, pl. 5, figs. 14-17.
Hantkenina (Cribrohantkenina) bermudezi Thalmann, 1942, Amer. Jour. Sci. vol. 240, pp. 812, 815, 819, pl. 1, figs. 5, 6.
Cribrohantkenina bermudezi Thalmann. Bolli, Loeblich, and Tappan, 1957, Bull. U. S. Nat. Mus. 215, pp. 28, 29, pl. 2, figs. 9a-11b.
Cribrohantkenina danvillensis (Howe and Wallace). Blow and Banner, Mid-Tertiary Stratigraphical Correlation, part 2, pp. 128-129, pl. 16, figs. g, h.
Cribrohantkenina inflata (Howe). Spraul, 1962, Trans. G. C. A. G. S., vol. 12, pp. 343-347, pl. 1, figs. 1a-4b.

Remarks: Spraul (1962) suggested that H. inflata, H. mccordi, H. danvillensis, and H. (Cribrohantkenina) bermudezi are conspecific. The apertural differences, the globosity of the younger chambers, and the length of the spines which may possibly constitute specific differences seem to be gradational and not restricted geographically or stratigraphically.

Family GLOBIGERINIDAE Carpenter

Subfamily GLOBOROTALIINAE Cushman

Genus GLOBOROTALIA Cushman

Globorotalia cerroazulensis (Cole)

Pl. 5, fig. 13, 14, 17-20

Globigerina cerro-azulensis Cole, 1929, Bull. Amer. Paleo., vol. 14, no. 53, p. 217, pl. 32, figs. 11-13.
Globorotalia cocoaensis Cushman, 1928, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 3, p. 75, pl. 10, fig. 3a-c.
Globorotalia cocoaensis Cushman. Cushman, 1935, U. S. G. S. Prof. Paper, 181, p. 50, pl. 21, figs. 1a-3c.
Globorotalia cocoaensis Cushman. Bolli, 1957, Bull. U. S. Nat. Mus., 215, p. 169, pl. 39, figs. 5a-7b.
Globorotalia (Turborotalia) cerro-azulensis (Cole). Blow and Banner, 1962, Mid-Tertiary Stratigraphical Correlation, part 2, p. 118, pl. 12, figs. d-f.

Remarks: Globigerina cerro-azulensis Cole and Globorotalia cocoaensis Cushman are apparently conspecific. Although the former is the senior synonym, a case might be made to the International Commission for conserving the name Globorotalia cocoaensis because of its extensive use in the Gulf Coast and Caribbean regions. This species exhibits a gradation from a distinctly keeled periphery to an angulate periphery to a rounded periphery. The size of the aperture is also variable. These characters on examination are gradational and do not show any geographic or stratigraphic patterns.

Genus PSEUDOHASTIGERINA Banner and Blow

Pseudohastigerina micra (Cole)

Pl. 5, fig. 1-3

Nonion micrus Cole, 1927, Bull. Amer. Paleo., vol. 14, no. 51, p. 22, pl. 5, fig. 12
Nonion micrum Cole. Monsour, 1937, Bull. A. A. P. G., vol. 21, no. 1, p. 85.
Hastigerina micra (Cole). Bolli, 1957, Bull. U. S. Nat. Mus., vol. 215, p. 161, pl. 35, figs. 1a-2b.
?Globigerinella iota (Finlay). Hornibrook, 1958, Micropaleo., vol. 4, no. 1, p. 34, pl. 1, figs. 22-24.
Pseudohastigerina micra (Cole). Banner and Blow, 1959, Paleontology, vol. 2, pt. 1, pp. 19-20, pl. 3, figs. 6a-b, text figs. 4g-i.

Remarks: This species shows early trochoid chambers, moderately inflated chambers, and coarsely perforate test wall. The initial chambers are often evident at the umbilical whorl and assignment to Pseudohastigerina seems to be correct.

Family UVIGERINIDAE Cushman

Subfamily UVIGERININAE Cushman

Genus STILOSTOMELLA Guppy

Stilostomella cocoaensis (Cushman)

Pl. 12, fig. 21

Nodosaria cocoaensis Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, p. 66, pl. 10, figs. 5, 6.
Dentalina cocoaensis (Cushman). Cushman, 1927, Jour. Paleo., vol. 1, p. 153, pl. 24, fig. 14.

Ellipsonodosaria cocoaensis (Cushman). Cushman, 1939, Contr. Cushman Foram. Res., vol. 15, p. 68, pl. 11, figs. 27, 33.
Nodosarella cocoaensis (Cushman). Bandy, 1949, Bull. Amer. Paleo., vol. 32, no. 131, pl. 7, figs. 2a, b.

Remarks. Bandy (1949) states that the type species of Ellipsonodosaria Sylvestri and Nodosarella Rzehak are congeneric. Finlay (1947) and Pokorny (1958) recognize Stilostomella Guppy as the senior synonym of both genera. Stainforth (1952b) comments on this problem as follows:

> "Finlay strongly urges the suppression of Ellipsonodosaria as a synonym of Nodosarella. He cites Martinotti to the effect that the early chambers of Nodosarella may be biserial in the microspheric form. Stainforth, 1952a preferred to regard Nodosarella as strictly uniserial and to use Ellipsoidella for the initially biserial forms, but recognized the difficulty of separating marginal species.
>
> "Finlay recognizes the synonomy of Siphonodosaria and Nodogenerina but draws attention to an awkward taxonomic point. Siphonodosaria Silvestri, 1924, was proposed as a genus with no designated species and ought to be considered a nude name until it was validated by Cushman, who referred Nodosaria abyssorum Brady to this genus in March 1927. Meanwhile Nodogenerina Cushman had been proposed, with N. bradyi as genotype, in January 1927. It can be argued from these facts that Nodogenerina has prior validity over Siphonodosaria. Finlay leaves this question open and goes on to claim that Stilostomella Guppy, 1894 is congeneric with Siphonodosaria and Nodogenerina and has priority over both of them. Stainforth, 1952, considered that Siphonodosaria was the valid name by priority of publication. He overlooked Stilostomella but here states the opinion that Finlay appears to be correct."

Stilostomella jacksonensis (Cushman and Applin)

Pl. 12, fig. 33

Nodosaria jacksonensis Cushman and Applin, 1926, Bull. A. A. P. G., vol. 10, p. 170, pl. 7, figs. 14-16.
Dentalina jacksonensis (Cushman and Applin). Cushman, 1935, U. S. G. S., Prof. Paper 181, p. 20, pl. 8, figs. 7-9.
Siphonodosaria jacksonensis (Cushman and Applin). Stainforth, 1952, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 12.

Remarks: The remarks pertaining to the generic placement of Stilostomella cocoaensis apply to this species as well.

Family CAUCASINIDAE Bykova

Subfamily FURSENKOININAE Loeblich and Tappan

Genus FURSENKOINA Loeblich and Tappan

Fursenkoina dibollensis (Cushman and Applin)

Pl. 12, fig. 22, 23

Virgulina dibollensis Cushman and Applin, 1926, Bull. A. A. P. G., vol. 10, p. 168, pl. 7, fig. 7.
Virgulina dibollensis var. *subtransversalis* Bandy, 1949, Bull. Amer. Paleo., vol. 32, no. 131, p. 137, pl. 26, figs. 10a-b.

Remarks: Loeblich and Tappan (1961) comment as follows:

> "*Fursenkoina nom. nov.* is herein proposed for *Virgulina* d'Orbigny, 1826, Ann. Sci. Nat. v. 7, p. 267 (*non Virgulina* Bory de St. Vincent, 1823(. Type species *Fursenkoina squammosa* (d'Orbigny)= *Virgulina squammosa* d'Orbigny, 1826."

Superfamily NODOSARIACEA Ehrenberg

Family NODOSARIIDAE Ehrenberg

Subfamily NODOSARIINAE Ehrenberg

Genus LANKESTERINA Loeblich and Tappan

Lankesterina frondea (Cushman)

Pl. 10, fig. 2, 3

Bolivina frondea Cushman, 1922, U. S. G. S. Prof. Paper 129-F, p. 126, pl. 29, fig. 3
Polymorphina frondea (Cushman). Cushman, 1929, Contr. Cushman Lab. Foram. Res., vol. 5, p. 41.

Remarks: Leoblich and Tappan (1961) comment on the generic assignment of this species as follows:

> "Originally described as *Bolovina*, the type species of the present genus was later transferred to *Polymorphina* by Cushman (1929) because of the radial aperture, which was illustrated by Cushman and Ozawa (1930). *Lankesterina* differs from *Polymorphina* in being completely symmetrical and in having truncate margins, similar to the other plamate genera of the Nodosariinae (*Dyofrondicularia*, *Frondicularia*, etc.), but differs from those in being biserial throughout. *Polymorphina* is somewhat asymmetrical particularly in its early development, and may show traces of sigmoid development."

BIBLIOGRAPHY

Bandy, O. L., 1949, Eocene and Oligocene Foraminifera from Little Stave Creek, Clarke County, Alabama: Bull. Am. Paleontology: v. 32, no. 131.

Banner, F. T. and Blow, W. H., 1959, The classification and stratigraphical distribution of the Globigerinaceae: Paleontology, v. 2, pt. 1, p. 1-27.

Banner, F. T. and Blow, W. H., 1960, The taxonomy, morphology and affinities of the genera included in the subfamily Hastigerininae: Micropaleontology, v. 6, p. 19-31.

Bold, William Aaldert van den, 1958a, Eocene and Oligocene Ostracoda from Trinidad: Micropaleontology, v. 6, no. 2, p. 145-196.

Bold, William Aaldert van den, 1958b, Ambocythere, A new genus of Ostracoda: Ann. Mag. Nat. Hist., ser. 12, v. 10, p. 801-813.

Bolli, H. M., 1957, Planktonic Foraminifera from the Eocene Navet and San Fernando formations of Trinidad, B.W.I.: U. S. Nat. Mus. Bull., no. 215, p. 155-172.

Bolli, H. M., Loeblich, A. R., and Tappan, Helen, 1957, Planktonic foraminiferal families, Hantkeninidae, Orbulinidae, Globorotalidae, and Globotruncanidae: U. S. Nat. Mus. Bull., no. 215, p. 3-50.

Cheetham, A. H., 1957, Eocene-Oligocene boundary, Eastern Gulf Coast region: Trans. Gulf Coast Assoc. Geol. Soc., v. 7, p. 89-97.

Cheetham, A. H., 1959, Late Eocene zoogeography of the eastern Gulf Coast region: Ph.D. dissertation, Columbia University.

Cole, W. S., 1927, A foraminiferal fauna from the Guayabal formation in Mexico: Bull. Am. Paleontology, v. 14, no. 51.

Cole, W. S., 1929, A Foraminiferal fauna from the Chapapote formation in Mexico: Bull. Am. Paleontology, v. 14, no. 53, p. 3-26.

Cooke, C. W., 1915, The age of the Ocala limestone: U. S. Geol. Survey, Prof. Paper 95, p. 107-117.

Cooke, C. W., 1918, Correlation of the deposits of Jackson and Vicksburg ages in Mississippi and Alabama: Wash. Acad. Sci. Jour., v. 8, p. 186-198.

Cooke, C. W., 1926, Geology of Alabama; the Cenozoic formations: Alabama Geol. Survey, Spec. Rept. no. 14, p. 251-297.

Cooke, C. W., 1923, The correlation of the Vicksburg Group: U. S. Geol. Survey Prof. Pap. 1933.

Cooke, C. W., 1925, Correlation of the Eocene formations in Mississippi and Alabama: U. S. Geol. Survey Prof. Paper 140, p. 133-136.

Cooke, C. W., 1935, Notes on the Vicksburg Group: Am. Assoc. Petroleum Geologists Bull., v. 19, no. 8, p. 1162-1172.

Cooke, C. W., Gardner, J. A., and Woodring, W. P., 1943, Correlation of the Cenozoic formations of the Atlantic and Gulf Coastal plain and the Caribbean region: Geol. Soc. Am. Bull., v. 54, no. 11, p. 1713-1723.

Cushman, J. A., 1920, Some relationships of the foraminiferal fauna of the Byram calcareous marl (Hinds County, Mississippi): Washington Acad. Sci. Jour., v. 10, no. 7, p. 198-201.

Cushman, J. A., 1922a, The Foraminifera of the Byram calcareous marl at Byram, Mississippi: U. S. Geol. Survey Prof. Paper 129, p. 87-122.

Cushman, J. A., 1922b, The Foraminifera of the Mint Spring calcareous marl member of the Mariana limestone: U. S. Geol. Survey Prof. Paper 129, p. 123-152.

Cushman, J. A., 1923, The Foraminifera of the Vicksburg Group: U. S. Geol. Survey Prof. Paper 133.

Cushman, J. A., 1925, Eocene Foraminifera from the Cocoa sand of Alabama: Contr. Cushman Lab. for Foram. Research, v. 1, p. 65-69.

Cushman, J. A., 1926, Some new Foraminifera from the upper Eocene of the southeastern coastal plain of the United States: Contr. Cushman Lab. for Foram. Research, v. 2, p. 29-36.

Cushman, J. A., 1929, Notes on the Foraminifera of the Byram marl: Contr. Cushman Lab. for Foram. Research, v. 5, p. 40-48.

Cushman, J. A., 1933, New Foraminifera from the upper Jackson Eocene of the southeastern coastal plain region of the United States: Contr. Cushman Lab. for Foram. Research, v. 9, p. 1-21.

Cushman, J. A., 1935a, Upper Eocene Foraminifera of the southeastern United States: U. S. Geol. Survey Prof. Paper 181.

Cushman, J. A., 1935b, New species of Foraminifera from the lower Oligocene of Mississippi: Contr. Cushman Lab. for Foram. Research, v. 11, p. 25-39.

Cushman, J. A., 1939, Eocene Foraminifera from the submarine cores off the eastern coast of North America: Contr. Cushman Lab. for Foram Research, v. 15, p. 49-76.

Cushman, J. A., 1946, A rich foraminiferal fauna from the Cocoa sand of Alabama: Cushman Lab. for Foram, Research Spec. Pub. 16.

Cushman, J. A., and Applin, E. R., 1926, Texas Jackson Foraminifera: Am. Assoc. Petroleum Geologists Bull., v. 10, p. 154-189.

Cushman, J. A., and McGlamery, W., 1938, Oligocene Foraminifera from Choctaw Bluff, Alabama: U. S. Geol. Survey Prof. Paper 189-D, p. 103-119.

Cushman, J. A., and McGlamery, W., 1939, New species of Foraminifera from the lower Oligocene of Alabama: Contr. Cushman Lab. for Foram. Research, v. 15, p. 45-49.

Cushman, J. A., and McGlamery, W., 1942, Oligocene Foraminifera near Millry, Alabama: U. S. Geol. Survey Prof. Paper 197-B, p. 65-84.

Cushman, J. A., and Todd, Ruth, 1945, Foraminifera of the type locality of the Moody's marl member of the Jackson formation of Mississippi: Cushman Lab. for Foram. Research, v. 21, p. 81-105.

Cushman, J. A., and Todd, Ruth, 1946, A foraminiferal fauna from the Byram marl at its type locality: Contr. Cushman Lab. for Foram. Research, v. 22, pt. 3, p. 76-102.

Cushman, J. A., and Todd, Ruth, 1948, Foraminifera from the Red Bluff-Yazoo section, Red Bluff, Mississippi: Contr. Cushman Lab. for Foram. Research, v. 24, p. 1-12.

Delaney, P. J. V., 1957, Stratigraphy of the Vicksburg equivalent of Louisiana: M.S. Thesis, Louisiana State University.

Eames, F. E., Banner, F. T., Blow, W. H., and Clarke, W. J., 1962, Fundamentals of mid-Tertiary stratigraphical correlation: Cambridge University Press.

Echols, Dorothy J., Schaeffer Katherine, M. M., 1960, Microforaminifera of the Marianna limestone (Oligocene), from Little Stave Creek, Alabama: Micropaleontology, v. 6, no. 4, p. 399-415.

Gardner, Julia, 1957, Little Stave Creek, Alabama-paleoecologic study: Geol. Soc. Am. Mem. 67, p. 573-588.

Gooch, D. D., 1939, Some Ostracoda of the genus Cythereis from the Cook Mountain Eocene of Louisiana: Jour. Paleontology, v. 13, p. 580-588.

Gravell, D. W., and Hanna, M. A., 1938, Subsurface Tertiary zones of correlation through Mississippi, Alabama, and Florida: Am. Assoc. Petroleum Geologists Bull., v. 22, no. 8, p. 984-1013.

Hendy, W. J., 1948, Notes on the stratigraphy of Northeastern Wayne County, Mississippi: 6th Field Trip Guidebook, Miss. Geol. Soc., p. 25-31.

Hilgard, E. W., 1860, Geology and agriculture of Mississippi: Jackson, Miss.

Holland, W. C., Hough, L. W., and Murray, G. E., 1952, Geology of Beauregard and Allen Parishes: Louisiana Geol. Survey Bull. 27.

Hornibrook, N. de B, 1958, New Zealand upper Cretaceous and Tertiary foramiferal zones and some overseas correlations: Micropaleontology, v. 4, p. 25-38.

Howe, H. V., 1928a, An observation of the range of the genus Hantkenina: Jour. Paleontology, v. 2, p. 13-14.

Howe, H. V., 1928b, Additions to the list of species occurring in the type Red Bluff clay, Hiwannee, Mississippi: Jour. Paleontology, v. 2, p. 173-176.

Howe, H. V., 1930a, The genus Bolivinella in the Oligocene of Mississippi: Jour. Paleontology, v. 4, p. 263-267.

Howe, H. V., 1930b, Distinctive new species of Foraminifera from the Oligocene of Mississippi: Jour. Paleontology, v. 4, p. 326-332.

Howe, H. V., 1933, Review of Tertiary stratigraphy of Louisiana: Am. Assoc. Petroleum Geol. Bull., v. 17, p. 613-655.

Howe, H. V., 1936, Ostracoda of the genus Eucythere from the Tertiary of Mississippi: Jour. Paleontology, v. 10, p. 143-145.

Howe, H. V., 1942, Fauna of the Glendon formation at its type locality (Alabama): Jour. Paleontology, v. 16, p. 264-271.

Howe, H. V., 1962, Ostracod Taxonomy: Louisiana State University Press.

Howe, H. V., and Chambers, J., 1935, Louisiana Jackson Eocene Ostracoda: Louisiana Geol. Survey Bull. 5.

Howe, H. V., and Law, John, 1936, Louisiana Vicksburg Oligocene Ostracoda: Louisiana Geol. Survey Bull. 7.

Howe, H. V., and Wallace, W. E., 1932, Foraminifera of the Jackson Eocene at Danville Landing on the Ouachita, Catahoula Parish, Louisiana: Louisiana Geol. Survey Bull. 2.

Howe, H. V. and Wallace, W. E., 134, Apertural characteristics of the genus Hantkenina with description of a new species: Jour. Paleontology: v. 8, p. 35-37, pl. 5.

Ivey, John B., 1957, Geology and ground water in the Monroeville area, Alabama: Alabama Geol. Survey Bull. 66.

Keij, A. J., 1957, Eocene and Oligocene Ostracoda at Belgium: Institut Royal des Sci. Nat. de Belgique Memoir no. 136.

Krutak, Paul R., 1961, Jackson Eocene Ostracoda from the Cocoa sand Alabama: Jour. Paleontology, v. 35, no. 4, p. 769-788.

Loeblich, A. R., and Tappan, Helen, 1961, Suprageneric classification of the Rhizopoda: Jour. Paleontology, v. 35, p. 245-330.

Loeblich, R. A., and Tappan, Helen, 1961, Remarks on the systematics of Sarkadina (Protozoa), renamed homonyms and new and validated genera: Proc. Bio. Soc. Washington, v. 74, p. 213-234.

Lowman, S. W., 1947, Sedimentary Facies in the Gulf Coastal plain: Am. Assoc. Petroleum Geologists Bull., v. 33, no. 12, p. 1937-1997.

MacNeil, F. S., 1944, Oligocene stratigraphy of Southeastern United States: Am. Assoc. Petroleum Geologists Bull., v. 28, no. 9, p. 1313-1354.

MacNeil, F. S., 1946, Geologic map of the Tertiary formations of Alabama: U. S. Geol. Survey Prelim. Map 45, scale 1:500,000.

MacNeil, F. S., 1947, Correlation chart for the outcropping Tertiary formations of the Eastern Gulf region; U. S. Geol. Survey Oil and Gas Invs. Prelim. Chart 29.

Maury, Carlotta J., 1902, A comparison of the Oligocene of Western Europe and Southern United States: Am. Paleontologists Bull., v. 3, no. 15.

McGlothlin, T., 1944, General Geology of Mississippi: Am. Assoc. Petroleum Geologists Bull., v. 28, no. 1, p. 29-62.

Mississippi Geological Society, 1945, Tertiary correlation chart, Mississippi: Mississippi Geol. Soc.

Monroe, W. H., 1946, Geology of the outcropping formations in the Jackson area, Mississippi: U. S. Geol. Survey Prelim. Map 65, Oil and Gas Investigations.

Monsour, E. T., 1937, Micro-Paleontologic analysis of Jackson Eocene of Eastern Mississippi: Am. Assoc. Petroleum Geologists Bull., v. 21, p. 80-96.

Monsour, E. T., 1948, Generalised stratigraphic discussion on the post-Claiborne sediments in Mississippi and correlation with equivalent age sediments in the Gulf Coast Province: 6th Field Trip Guidebook, Mississippi Geol. Soc., p. 3-16, charts between p. 2 and 3.

Moore, R. C. (editor), 1961, Treatise on invertebrate paleontology-Arthropoda, pt. Q: Univ. Kansas Press and Geol. Soc. Am.

Mornhinveg, A. R., 1941, The Foraminifera of Red Bluff (Mississippi): Jour. Paleontology, v. 15, no. 4, p. 431-435.

Mullins, R. L., 1962, Ostracoda occurrence in the Perdue Hill section, Alabama: Louisiana State University Master's Thesis.

Murray, G. E., 1947, Genozoic deposits of the Central Gulf Coastal Plain: Am. Assoc. Petroleum Geologists Bull., v. 31, no. 10, p. 1825-1850.

Murray, G. E., 1950, Lithologic facies of the Jacksonian Stage, Central and Eastern Gulf Coast (abs.): Oil and Gas Jour., v. 48, no. 51, p. 123-172.

Murray, G. E. and Wilbert, L. J, 1950, Jacksonian Stage: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 10, p. 1990-1997.

Murray, G. E., 1952a, Vicksburg stage and Mosley Hill formation: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 4, p. 700-707.

Murray, G. E., 1952b, Volume of Mesozoic and Cenozoic sediments in the Central Gulf Coastal Plain of the United States: Geol. Soc. America Bull., v. 63, no. 12, part III, p. 1177-1192.

Murray, G. E., 1961, Geology of the Atlantic and Gulf Coastal Province of North America: Harper and Brothers, New York.

Pokorny, Vladimir, 1958, Grundzuge der Zoologischen Mikropalaontologie: Bd. I und II.

Simpson, George Gaylord, 1947, Holartic mammalian faunas and continental relationship during the Cenozoic: Geol. Soc. America Bull., v. 58, no. 7, p. 613-688.

Simpson, George Gaylord, 1960, Notes on the measurement of faunal resemblence: Am. Jour. Sci., Bradley Volume, v. 258-A, p. 300-311.

Smith, R. H., Osanik, A., Hendy, W., Wilbert, L. J., Wasem, R., Monsour, E., Thomas, P., and Murray, G. E., 1944, Stratigraphic section at Little Stave Creek, one mile north of Jackson, Clarke County, Alabama: Guidebook First Field Trip Southeastern Geol. Soc.

Spraul, G. L., 1962, Current status of the upper Eocene foraminiferal guide fossil, *Cribrohantkenina*: Trans. Gulf Coast Assoc. Geol. Soc., v. 12, p. 363-368.

Spraul, G. L., 1963, Current status of the upper Eocene foraminiferal guide fossil, *Cribrohantkenina*: Jour. Paleontology, v. 37, no. 2, p. 366-370.

Stainforth, R. M., 1952a, Classification of uniserial calcareous Foraminifera: Contr. Cushman Lab. for Foram. Research, v. 3, pt. 1, p. 6-14.

Stainforth, R. M., 1952b, Nodosaria nomenclature: Contr. Cushman Lab. for Foram. Research, v. 3, pts. 3 and 4, p. 146.

Stuckey, Charles W. Jr., 1960, A correlation of the Gulf Coast Jackson: Trans. Gulf Coast Assoc. Geol. Soc., v. 10, p. 285-298.

Thalman, H. E., 1942, Foraminiferal genus Hantkenina and its subgenera: Am. Jour. Sci., v. 240, p. 809-820.

Tonti, E. C., 1955, Certain disconformities and lithology of the Vicksburg stage of southeastern United States: Ph.D. dissertation, Louisiana State University.

Toulmin, L. D., 1940, The Salt Mountain limestone of Alabama: Alabama Geol. Survey Bull. 46.

Toulmin, L. D., 1944, General features of the Tertiary formations in Alabama: Southeastern Geol. Soc. Guidebook, p. 5-15.

Toulmin, L. D., 1952, Volume of Cenozoic sediments in Florida and Georgia, part II of sedimentary volumes in Gulf Coastal Plain of the United States and Mexico: Geol. Soc. America Bull., v. 63, p. 1165-1176.

Toulmin, L. D., 1955, Cenozoic geology of Southeastern Alabama, Georgia and Florida: Am. Assoc. Petroleum Geologists Bull., v. 39, p. 207-235.

Triebel, E., 1940, Die Ostracoden der Deutschen Kreide: Senckenbergiana, Bd. 22, p. 160-227.

EXPLANATION OF PLATES

Plate I

Figure

1, 2. Cytherelloidea cocoaensis Krutak; male RV (fig. 1), female LV (fig. 2), X50; Cocoa at locality 1, sample 13

3. Eucythere woodwardensis Howe; LV, X 50; Pachuta at locality 2, sample 6

4. Digmocythere watervalleyensis (Howe & Chambers); LV, X 50, Cocoa at locality 5, sample 13

5. Cytherella sp. 1; LV, X 50; Marianna at locality 3, sample 2

6. Krithe n. sp. 1; LV, X 50; Red Bluff at locality 4, sample 4

7. Cushmanidea n. sp. 1; RV, X 50; Pachuta at locality 5, sample 12

8. Cytherella sp. 1; RV, X 50; Marianna at locality 3, sample 2

9. Krithe hiwanneensis Howe & Lea; RV, X 60; Shubuta at locality 1, sample 13

10. Paracypria rosefieldensis Howe & Law; RV, X 40; Red Bluff at locality 2, sample 6

11. Propontocypris mississippiensis (Howe & Law); LV, X 40; Red Bluff at locality 5, sample 4

12. Cytheretta jacksonensis (Meyer); LV, X 40; Cocoa at locality 1, sample 17

13. Pterygocythereis murrayi (Hill); LV, X 60; Shubuta at locality 1, sample 11

14. Bythocypris gibsonensis Howe & Chambers; LV, X 40; Red Bluff at locality 2, sample 5

15. Bairdia sp. 1; LV, X 40; Shubuta at locality 5, sample 11

16. Digmocythere russelli (Howe & Lea); RV, X 40; Shubuta at locality 1, sample 12

17. Argilloecia hiwanneensis Howe & Law; RV, X 60; Shubuta at locality 1, sample 12

18. Bairdoppilata ocalana (Puri); RV, X 40, Pachuta at locality 5, sample 12

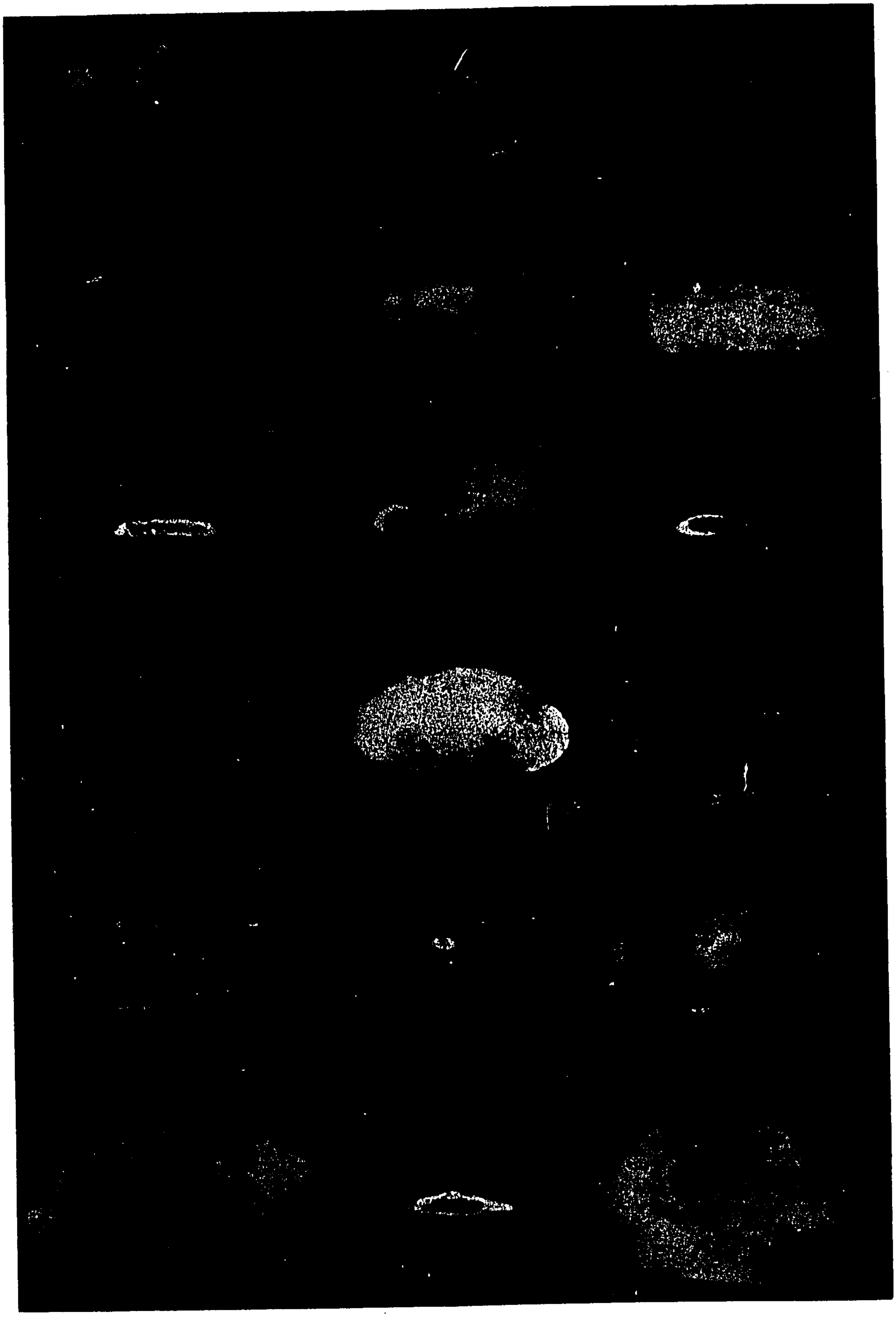


Plate I

Plate II

Figure

1. Buntonia n. sp. 1; female LV, X 50; Shubuta at locality 1, sample 12
2. Occultocythereis broussardi (Howe & Chambers); LV, X 50; Cocoa at locality 1, sample 17
3. Paracytheridea belhavenensis Howe & Chambers; RV, X 50; Pachuta at locality 7, sample 8
4. Buntonia n. sp. 1; male RV, X 50; Shubuta at locality 1, sample 12
5. Cytheropteron donvillensis Howe & Chambers; LV, X 50; Shubuta at locality 1, sample 13
6. Paracytheridea woodwardensis Howe & Law; LV, X 50; Marianna at locality 4, sample 1
7. Buntonia israelskyi (Howe & Ppyeatt); RV, X 50; Shubuta at locality 1, sample 12
8. Loxoconcha concentrica Krutak; RV, X 50; Shubuta at locality 4, sample 10
9. Loxoconcha creolensis Howe & Chambers; RV, X 50; Pacuta at locality 4, sample 13
10. Ambocythere n. sp. 1; RV, X 50; Marianna at locality 5, sample 1
11. Konarocythere spurgeonae (Howe & Chambers); LV, X 50; locality 4, sample 13
12. Hemicythere kniffeni Howe & Law; LV, X 50; Mint spring at locality 3, sample 3

13. _Cyamocytheridea_ _watervalleyensis_ (Stephenson); RV, X 50; Cocoa at locality 5, sample 13

14, 15. _Triginglymus_ n. sp. 1; RV (fig. 14), LV (fig. 15), X 50 Cocoa at locality 1, sample 17

16. _Brachcythere_ _mississippiensis_ (Meyer); LV, X 50; Cocoa at locality 1, sample 17

17. _Pterygocythereis_ _ivani_ (Howe & Law); LV, X 50; Red Bluff at locality 2, sample 6

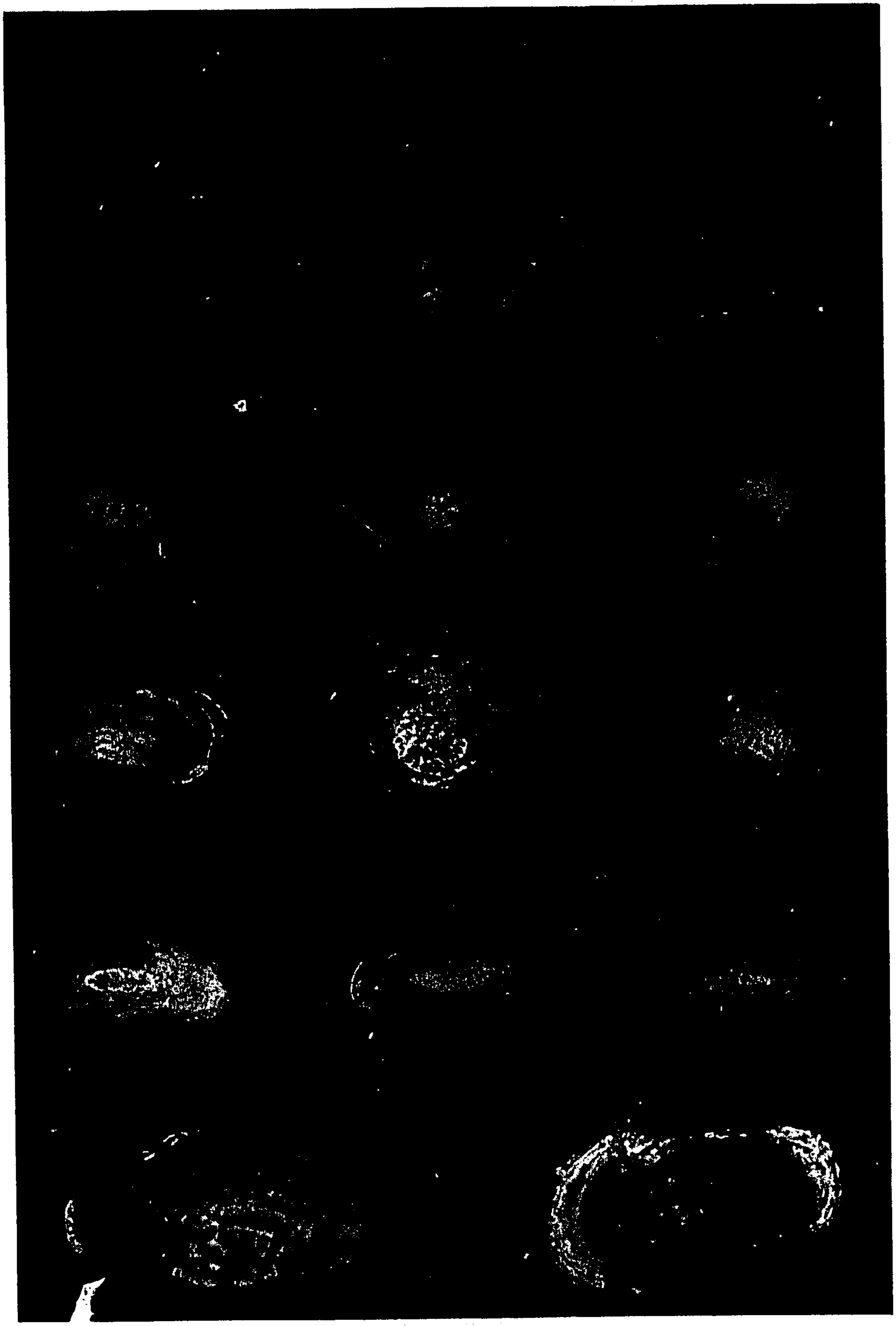


Plate II

Plate III

Figure

1. Haplocytheridea montgomeryensis (Howe & Chambers); RV, X 50; Shubuta at locality 1, sample 13

2. Haplocytheridea n. sp. 1; RV, X 50; Shubuta at locality 1, sample 15

3. Haplocytheridea ehlersi (Howe & Stephenson); RV, X 50; Shubuta at locality 1, sample 13

4. Clithrocytheridea grigsbyi (Howe & Chambers); LV, X 50; Pachuta at locality 1, sample 16

5. Clithrocytheridea garretti (Howe & Chambers); RV, X 50; Pachuta at locality 1, sample 16

6. Clithrocytheridea caldwellensis (Howe & Chambers); LV, X 50; Pachuta at locality 4, sample 12

7. Isocythereis couleycreekensis (Gooch); LV, X 50; Shubuta at locality 1, sample 14

8, 9. Henryhowella florienensis (Howe & Chambers); RV (fig. 8), LV, (fig. 9), X 50; Shubuta at locality 1, sample 13

10. Trachyleberidea blanpiedi (Howe); LV, X 50; Red Bluff at locality 2, sample 6

11, 12. Henryhowella florienensis (Howe & Chambers); male LV (fig. 11), female LV (fig. 12), X 50; Shubuta at locality 1, sample 13

13. Trachyleberidea blanpiedi (Howe); RV, X 50; Red Bluff at locality 2, sample 6

14, 15. N. Gen. n. sp. 1; LV (fig. 14), RV (fig. 15), X 50; Pachuta at locality 1, sample 16

16, 17. Jugosocythereis bicarinata (Swain); LV (fig. 16), RV (fig. 17), X 50; Cocoa at locality 5, sample 13

18. Jugosocythereis vicksburgensis (Howe & Law); RV, X 50; Mint spring at locality 3, sample 3

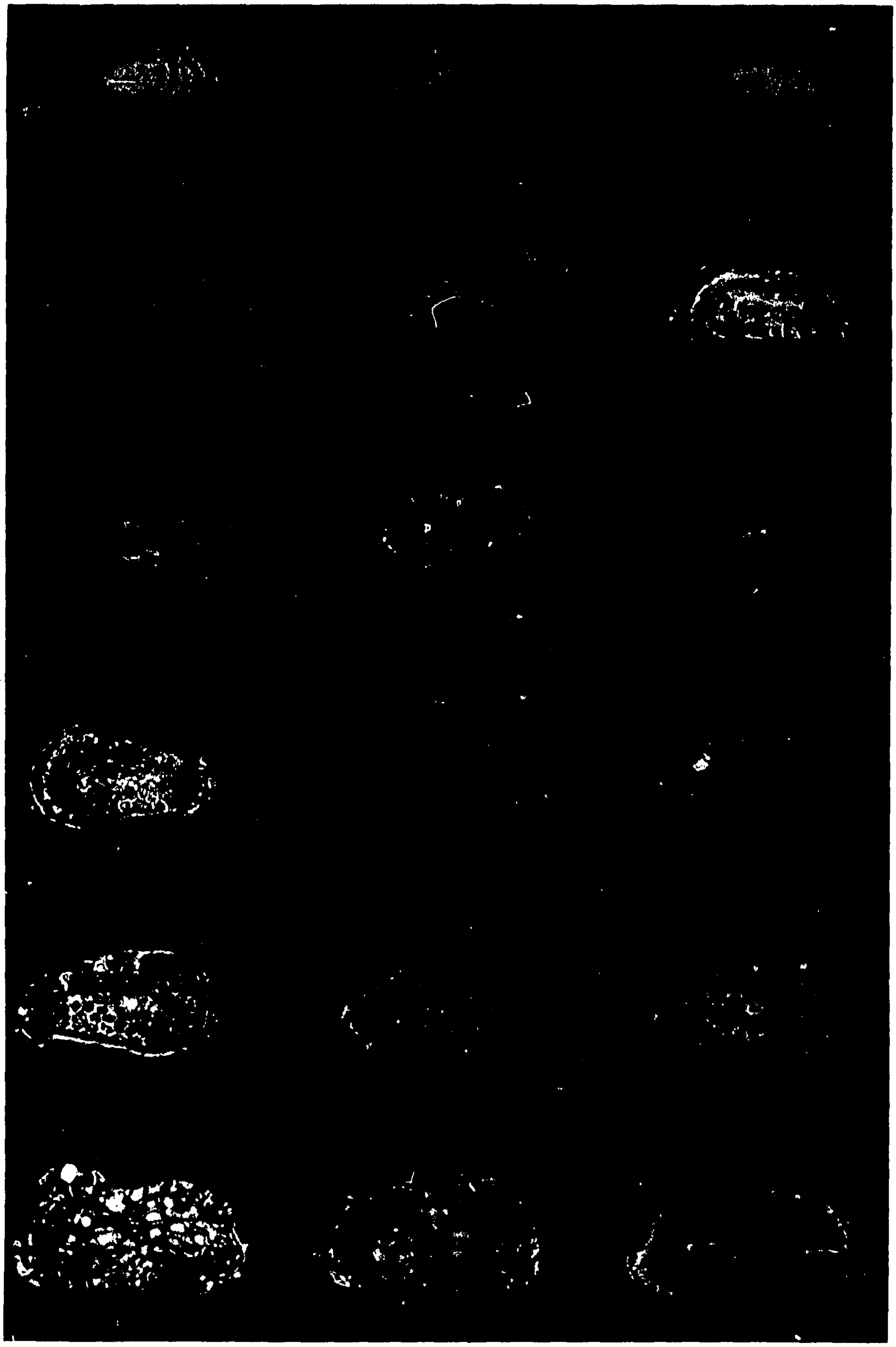


Plate III

Plate IV

Figure

1\. "Cythereis" dohmi Howe & Chambers; RV, X 50; Shubuta at locality 1, sample 13

2, 3. "Cythereis" hysonensis Howe & Chambers; LV (fig. 2), RV (fig. 3), X 50; Pachuta at locality 1, sample 16

4, 5. Actinocythereis dacyi (Howe & Law); male LV (fig. 4), female LV (fig. 5), X 50; Red Bluff at locality 2, sample 6

6\. Actinocythereis gibsonensis (Howe & Chambers); RV, X 50, Cocoa at locality 1, sample 17

7\. Actinocythereis n. sp. 1; RV, X 50; Shubuta at locality 1, sample 15

8\. Actinocythereis n. sp. 2; RV, X 50; Cocoa at locality 1, sample 17

9, 10. Trachyleberis montgomeryensis (Howe & Chambers); male RV (fig. 9), female LV (fig. 10), X 50; Shubuta at locality 1, sample 13

11, 12. Trachyleberis n. sp. 1; male RV (fig. 11), female RV (fig. 12), X 50; Shubuta at locality 2, sample 9

13\. Trachyleberis montgomeryensis (Howe & Chambers); female LV, X 50; Shubuta at locality 1, sample 13

14\. Acanthocythereis n. sp. 1; female RV, X 50; Shubuta at locality 1, sample 13

15\. Echinocythereis mcguirti (Howe); LV, X 50; Red Bluff at locality 2, sample 7

16\. Trachyleberis n. sp. 2; male RV, X 50; Red Bluff at locality 4, sample 6

17. Acanthocythereis n. sp. 1; male RV, X 50; Shubuta at locality 1, sample 13

18. Echinocythereis jacksonensis (Howe & Pyeatt); male LV, X 50; Shubuta at locality 1, sample 13

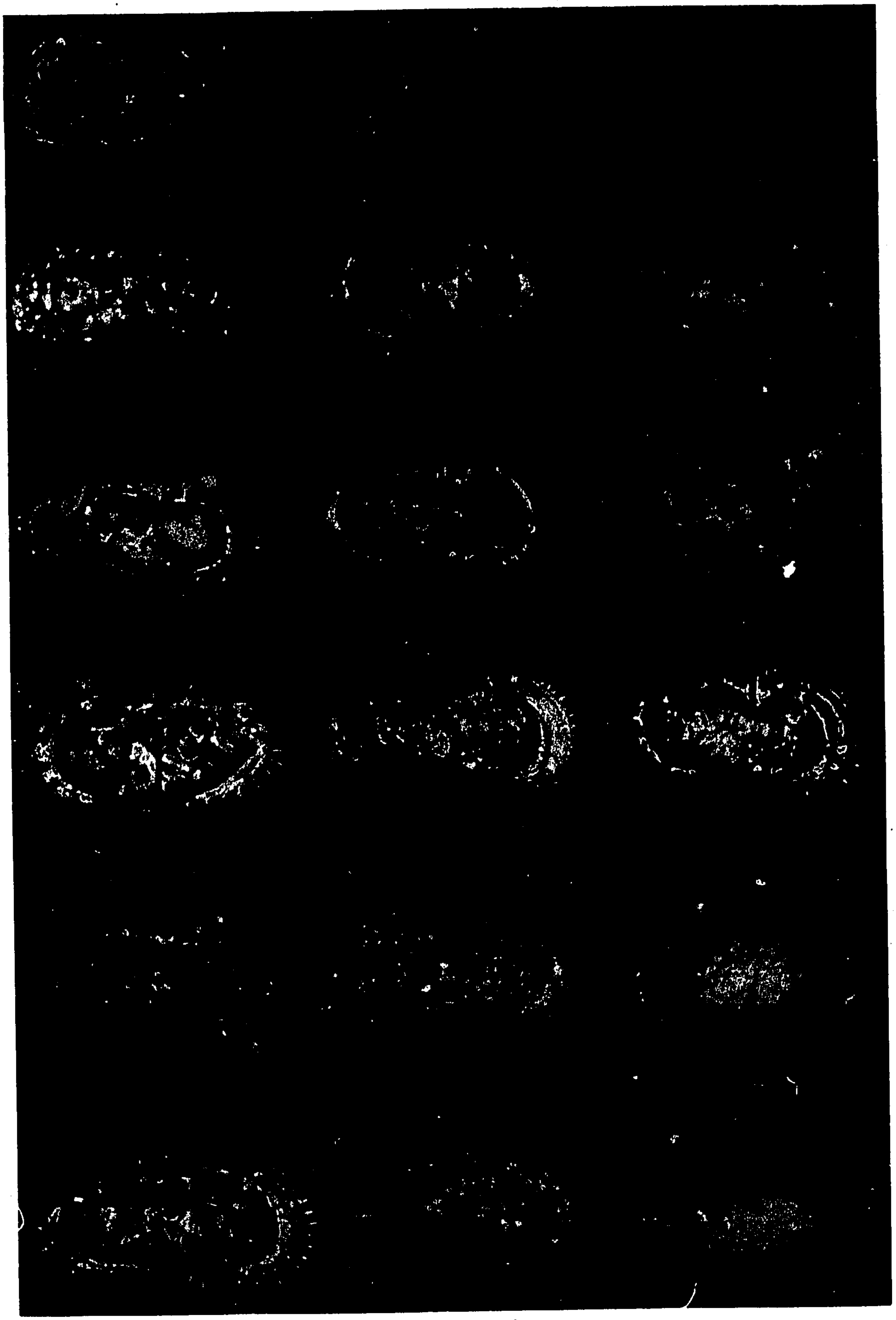


Plate IV

Plate V

Figures

1, 2, 3. Pseudohastigerina micra (Cole); peripheral view (fig. 1), side views (figs. 2, 3), X 100; Shubuta at locality 1, sample 12

4. Cribrohantkenina inflata (Howe); peripheral view, X 50; Shubuta at locality 1, sample 13

5. Hantkenina alabamensis Cushman; side view, X 50; Shubuta at locality 1, sample 13

6. Cribrohantkenina inflata (Howe); side view, X 50; Shubuta at locality 1, sample 13

7, 8. Hantkenina alabamensis Cushman; side views, X 50; Shubuta at locality 1, sample 13

9, 10. Globorotalia increbescens (Bandy); dorsal view (fig. 9), ventral view (fig. 10), X 75; Shubuta at locality 1, sample 12

11, 12. Hastigerina danvillensis (Howe); side views, X 75; Shubuta at locality 1, sample 10

13, 14. Globorotalia cerroazulensis (Cole); dorsal views of keeled (fig. 13) and unkeeled (fig. 14) forms, X 50; Shubuta at locality 1, sample 13

15, 16. Globigerina ouachitaensis Howe & Wallace; ventral view (fig. 15), dorsal view (fig. 16), X 100; Shubuta at locality 5, sample 9

17, 18, 19, 20. Globorotalia cerroazulensis (Cole); ventral view keeled form (fig. 17), peripheral view keeled form (fig. 18), peripheral view unkeeled form (fig. 19), ventral view unkeeled form (fig. 20), X 50; Shubuta at locality 1, sample 14

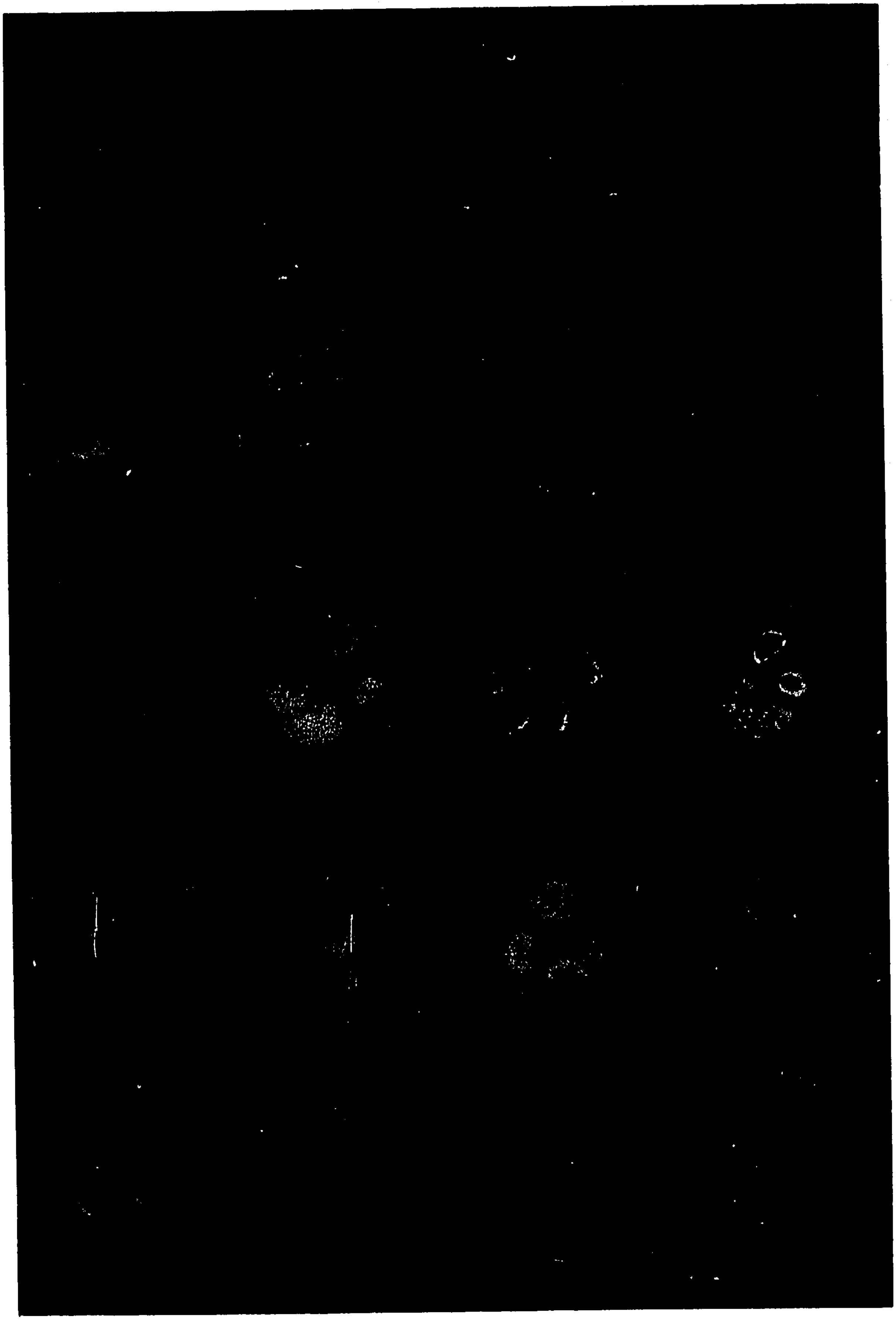


Plate V

Plate VI

Figure

1, 2, 3. Globorotalia centralis Cushman & Bermudez; dorsal view (fig. 1), peripheral view (fig. 2), ventral view (fig. 3), X 50; Shubuta at locality 1, sample 9

4, 5. Globigerinita dissimilis (Cushman & Bermudez); ventral views, X 50; Marianna at locality 3, sample 2

6. Globigerina ampliapertura Bolli; ventral view, X 50; Red Bluff at locality 2, sample 5

7, 8. Globigerina pseudoampliapertura Blow & Banner; dorsal view (fig. 7), ventral view (fig. 8), X 50; Shubuta at locality 1, sample 11

9. Globigerina ampliapertura Bolli; dorsal view, X 50; Red Bluff at locality 2, sample 5

10. Globigerina yeguaensis pseudovenezuelana Blow & Banner; ventral view, X 50; Shubuta at locality 1, sample 12

11, 12. Globigerina tripartita tripartita Koch; dorsal view (fig. 11), ventral view (fig. 12), X 50; Shubuta at locality 1, sample 13

13. Globigerina yeguaensis pseudovenezuelana Blow & Banner; ventral view, X 50; Shubuta at locality 1, sample 13

14, 15. Globigerina n. sp. 1; dorsal view (fig. 14), ventral view (fig. 15), X 50; Shubuta at locality 1, sample 13

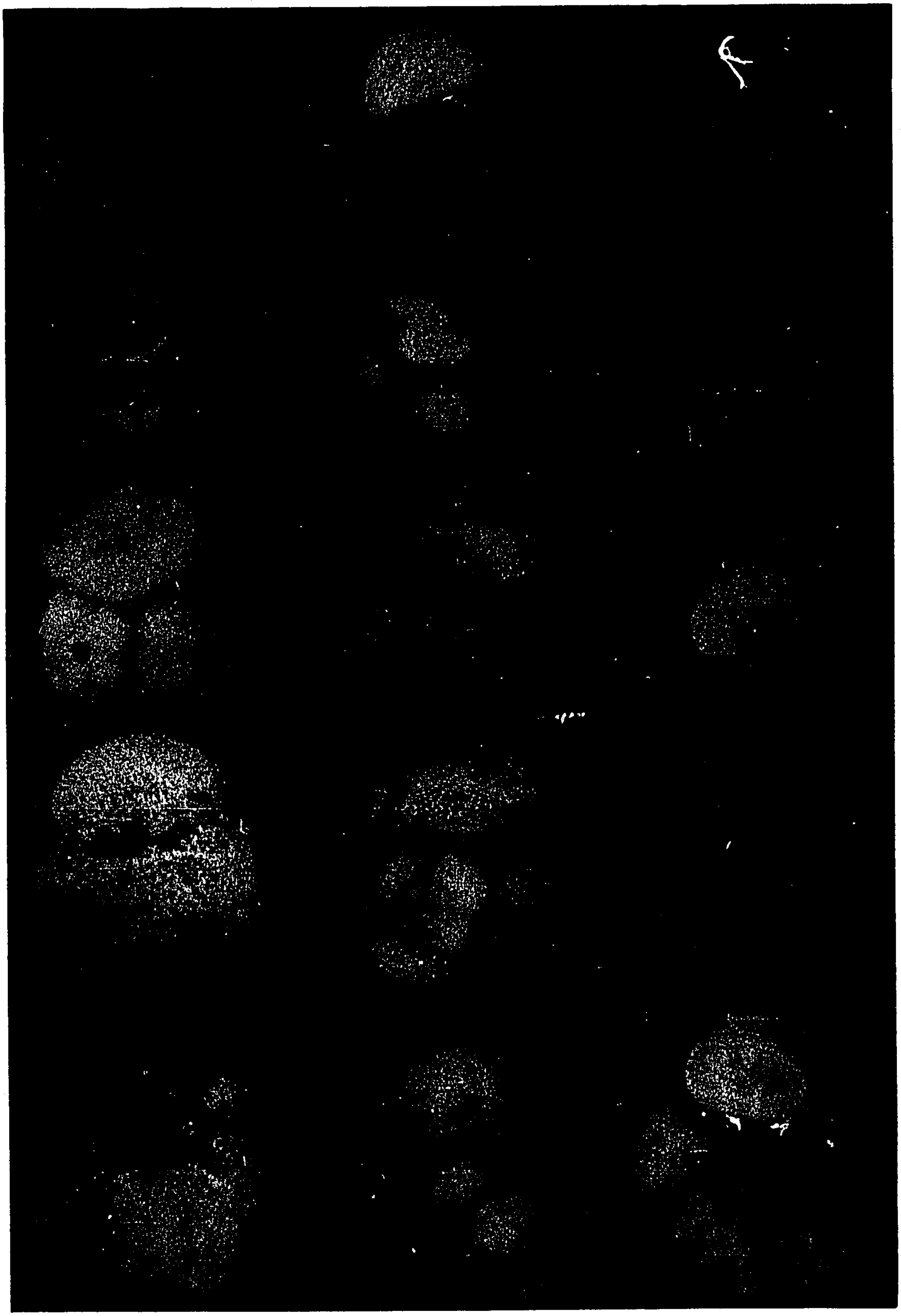


Plate VI

Plate VII

Figure

1. Globigerina yeguaensis pseudovenezuelana Blow & Banner; dorsal view, X 50; Shubuta at locality 1, sample 12

2, 3. Globigerinita pera (Todd); ventral views, X 50; Shubuta at locality 5, sample 9

4. Globigerina yeguaensis yeguaensis Weinzierl & Applin; dorsal view, X 50; Shubuta at locality 1, sample 12

5. Globigerinita pera (Todd); ventral view, X 50; Shubuta at locality 5, sample 9

6, 7. Globigerina yeguaensis yeguaensis Weinzierl & Applin; ventral views, X 50; Shubuta at locality 1, sample 12

8. Globigerinita pera (Todd); dorsal view, X 50; Shubuta at locality 5, sample 9

9. Globigerina turritilina praeturritilina Blow & Banner; ventral view, X 50; Shubuta at locality 4, sample 8

10, 11. Globigerina gortanii (Borsetti); ventral views, X 50; Shubuta at locality 1, sample 8

12. Globigerina turritilina praeturritilina Blow & Banner; dorsal view, X 50; Shubuta at locality 4, sample 8

13, 14. Globigerina gortanii (Borsetti); ventral view (fig. 13), dorsal view (fig. 14), X 50; Shubuta at locality 1, sample 8

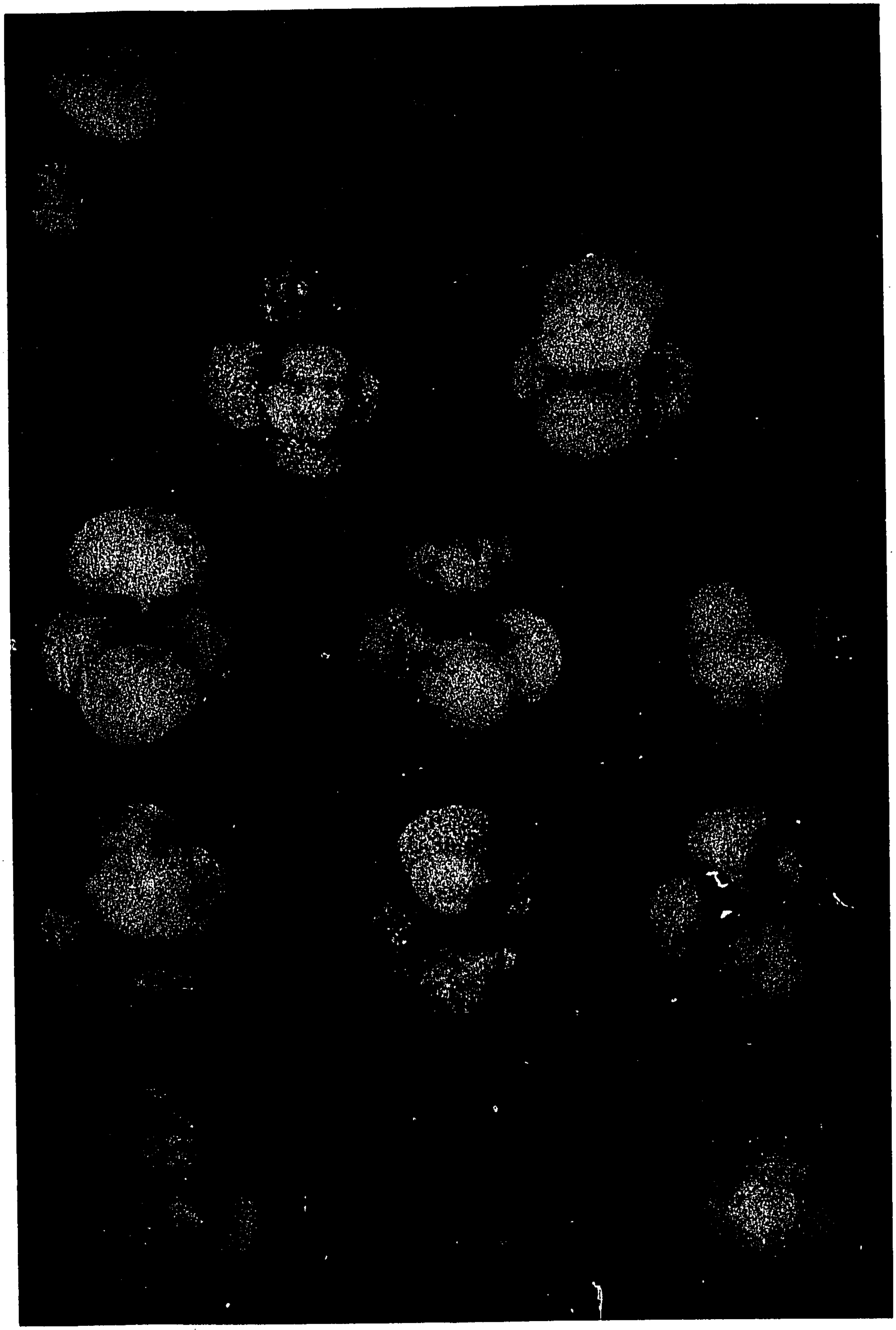


Plate VII

Plate VIII

Figure

1. Spiroplectammina alabamensis (Cushman); side view, X 50; Red Bluff at locality 4, sample 6
2. Spiroplectammina mississippiensis (Cushman); side view, X 50; Shubuta at locality 1, sample 11
3. Spirolplectammina alabamensis (Cushman); side view, X 50; Red Bluff at locality 4, sample 6
4. Textularia conica D'Orbigny; side view, X 50; Marianna at locality 4, sample 2
5. Textularia sp. 1; side view, X 50; Pachuta at locality 4, sample 12
6. Textularia recta Cushman; side view, X 50; Pachuta at locality 4, sample 13
7. Textularia tumidulum Cushman; side view, X 50; Marianna at locality 3, sample 1
8. Textularia hauerii Cushman; side view, X 30; Red Bluff at locality 2, sample 4
9. Textularia sp. 3; side view, X 50; Pachuta at locality 1, sample 16
10. Spiroplectammina mississippiensis (Cushman); side view X 50; Shubuta at locality 1, sample 10
11. Liebusella byramensis (Cushman); side view, X 30; Shubuta at locality 1, sample 10
12. Liebusella byramensis turgida (Cushman); side view, X 30; Red Bluff at locality 4, sample 4
13. Textularia porrecta Brady; side view, X 50; Pachuta at locality 1, sample 16

14. *Textularia adalta* Cushman; side view, X 30; Cocoa at locality 1, sample 17

15. *Textularia dibollensis* Cushman & Applin; side view, X 50; Cocoa at locality 1, sample 17

16. *Pseudogaudryina jacksonensis* Cushman; side view, X 30; Shubuta at locality 1, sample 13

17. *Pseudogaudryina* sp. 1; side view, X 30; Shubuta at locality 4, sample 7

18. *Karrerierlla advena* (Cushman); side view, X 50; Shubuta at locality 1, sample 12

19. *Textularia subhauerii* Cushman; side view, X 30; Marianna at locality 3, sample 2

20. *Textularia* sp. 2; side view, X 50; Cocoa at locality 1, sample 17

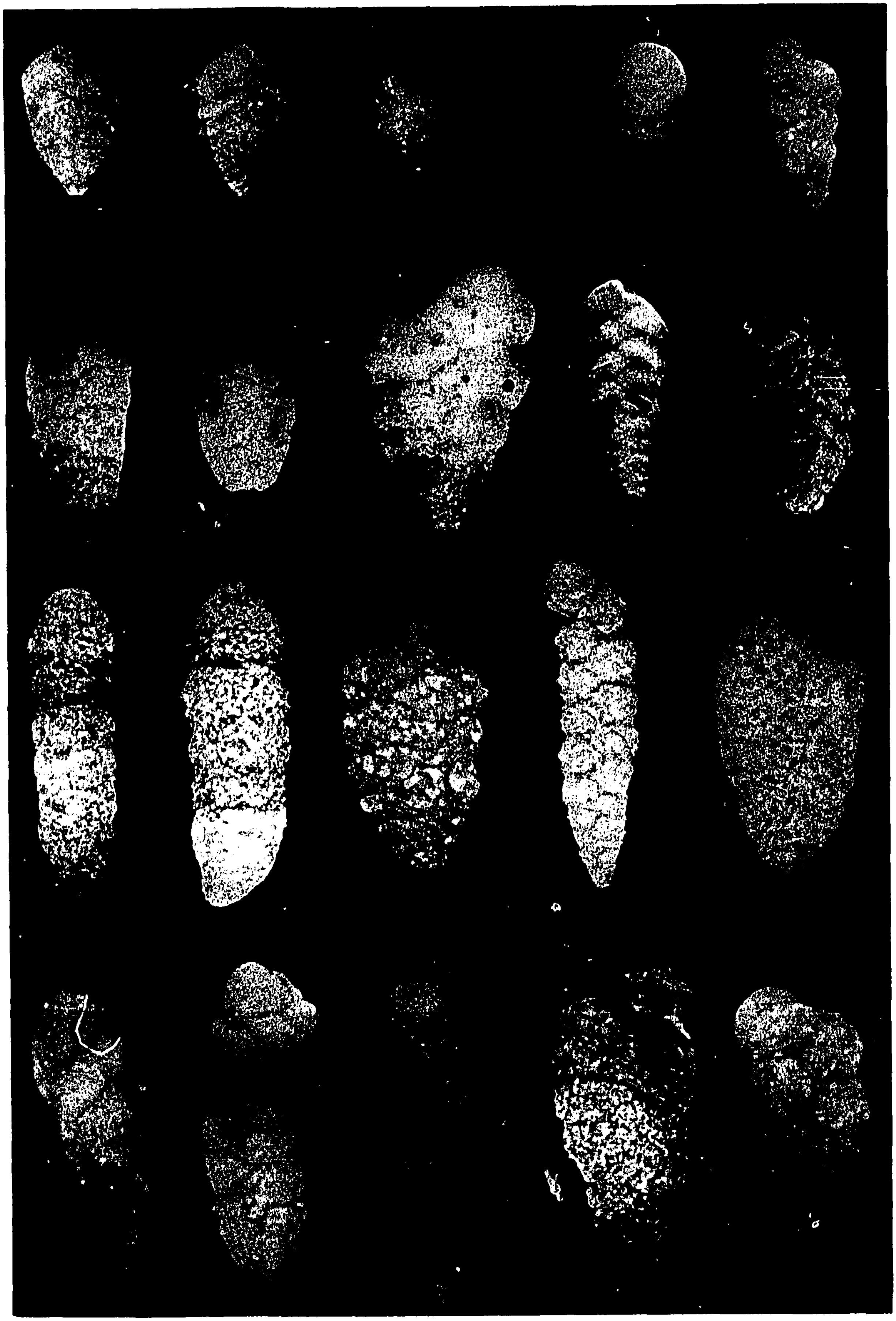


Plate VIII

Plate IX

Figure

1, 2. *Cyclammina* sp. 1; side view, X 50; Red Bluff at locality 2, sample 6

3. *Ammobaculites subagglutinans* Bandy; side view, X 50; Marianna at locality 4, sample 2

4. *Pseudoclavulina cocoaensis* Cushman; side view, X 50; Shubuta at locality 1, sample 12

5. *Vulvulina advena* Cushman; side view X 50; Shubuta at locality 1, sample 13

6, 7. *Massilina decorata* Cushman; side views, X 75; Red Bluff at locality 4, sample 6

8. *Spiroloculina* sp. 1; side view, X 75; Red Bluff at locality 4, sample 6

9. *Spiroloculina occulsa* (Cushman); side view, X 75; Red Bluff at locality 2, sample 6

10. *Massilina cookei* Cushman; side view, X 50; Shubuta at locality 1, sample 10

11, 12. *Guttulina spicaeformis* (Roemer); side view, X 50; Shubuta at locality 1, sample 13

13. *Globulina alabamensis* Cushman & McGlamery; side view X 50; Red Bluff at locality 2, sample 4

14. *Globulina inaequalis caribbea* Reuss; side view, X 50; Pachuta at locality 1, sample 16

15. *Cornuspira involvens* Cushman; side view, X 50; Red Bluff at locality 2, sample 6

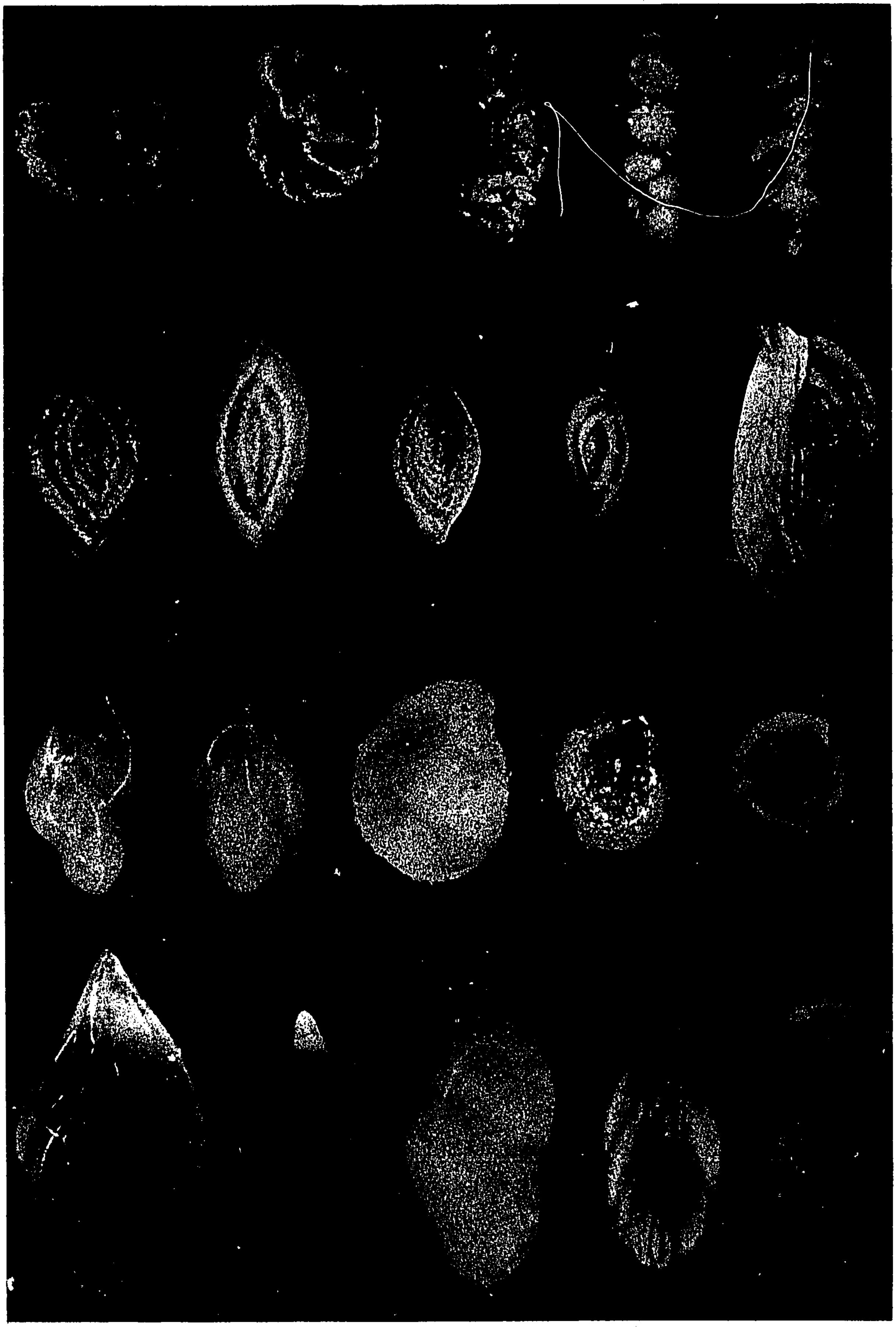


Plate IX

Plate X

Figure

1. *Plectofrondicularia garretti* (Cushman); side view, X 50; Shubuta at locality 1, sample 12

2, 3. *Lankesterina frondea* (Cushman); side views, X 75; Pachuta at locality 1, sample 16

4. *Flabellina lanceolata* Bandy; side view, X 50; Shubuta at locality 4, sample 8

5. *Flabellina* sp. 1; side view, X 50; Shubuta at locality 4, sample 8

6. *Palmula* cf. *vaughni* Cushman; side view, X 50; Shubuta at locality 1, sample 13

7, 8. *Palmula caelata* (Cushman); side views, X 50; Marianna at locality 4, sample 2

9. *Frondicularia tenuissima* Hantken; side view, X 50; Shubuta at locality 1, sample 13

10. *Guttulina* sp. 1; side view, X 50; Marianna at locality 5, sample 2

11, 12. *Globulina gibba* d'Orbigny; side view, X 50; Marianna at locality 3, sample 2

13. *Ramulina* sp.; X 50; Shubuta at locality 1, sample 12

14. *Guttulina irregularis* Cushman; side view, X 50; Shubuta at locality 1, sample 11

15, 16. *Guttulina problema* Cushman; side views, X 50; Marianna at locality 5, sample 2

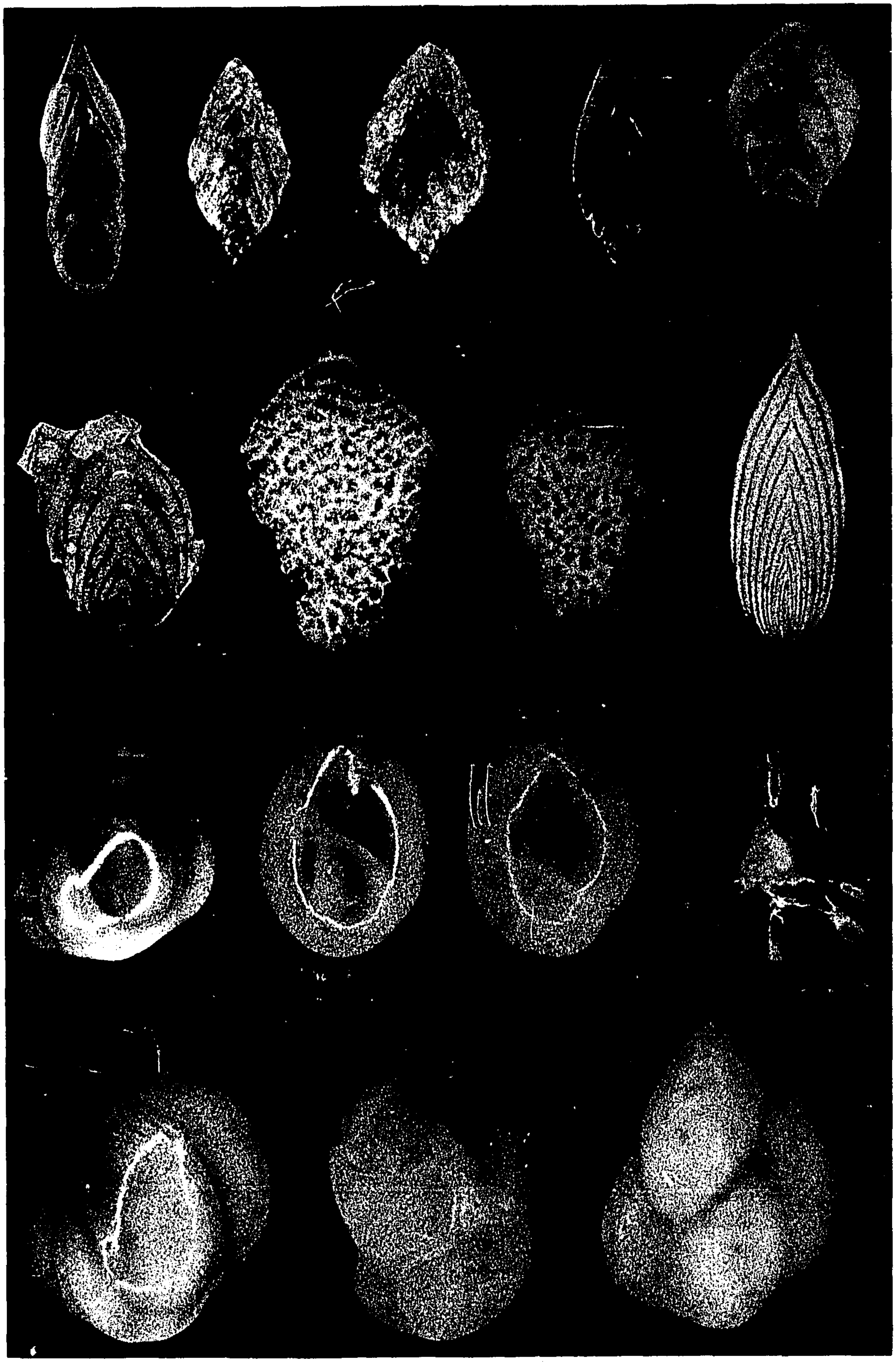


Plate X

Plate XI

Figure

1. *Uvigerina gardnerae* Cushman; side view, X 60; Shubuta at locality 1, sample 13

2, 3. *Bulimina ovata* d'Orbigny; side views, X 50; Shubuta at locality 1, sample 10

4. *Uvigerina* sp. 1; side view, X 60; Cocoa at locality 7, sample 9

5. *Reusella byramensis* Cushman; side view, X 50; Marianna at locality 3, sample 1

6. *Uvigerina gardnerae* Cushman; side view, X 60; Shubuta at locality 1, sample 13

7. *Uvigerina cocoaensis* Cushman; side view, X 50; Shubuta at locality 1, sample 13

8. *Uvigerina vicksburgensis* Cushman & Ellisor; side view X 50; Red Bluff at locality 2, sample 4

9. *Uvigerina topilensis* Cushman; side view, X 50; Shubuta at locality 1, sample 12

10. *Uvigerina jacksonensis* Cushman; side view, X 50; Pachuta at locality 4, sample 12

11. *Uvigerina glabrans* Cushman; side view, X 50; Shubuta at locality 1, sample 12

12. *Uvigerina cocoaensis* Cushman; side view, X 50; Shubuta at locality 1, sample 13

13. *Uvigerina* sp. 1; side view, X 60; Cocoa at locality 7, sample 9

14. *Uvigerina byramensis* Cushman; side view, X 50; Marianna at locality 3, sample 2

15. *Uvigerina* sp. (2 apertured); side view, X 50; Shubuta at locality 1, sample 13

16, 17. *Bulimina jacksonensis* Cushman; side views; X 40; Shubuta at locality 1, sample 13

18. *Uvigerina jacksonensis* Cushman; side view, X 50; Pachuta at locality 4, sample 12

19. *Uvigerina topilensis* Cushman; side view, X 50; Shubuta at locality 1, sample 12

20. *Uvigerina dumblei* Cushman & Applin; side view, X 50; Shubuta at locality 4, sample 9

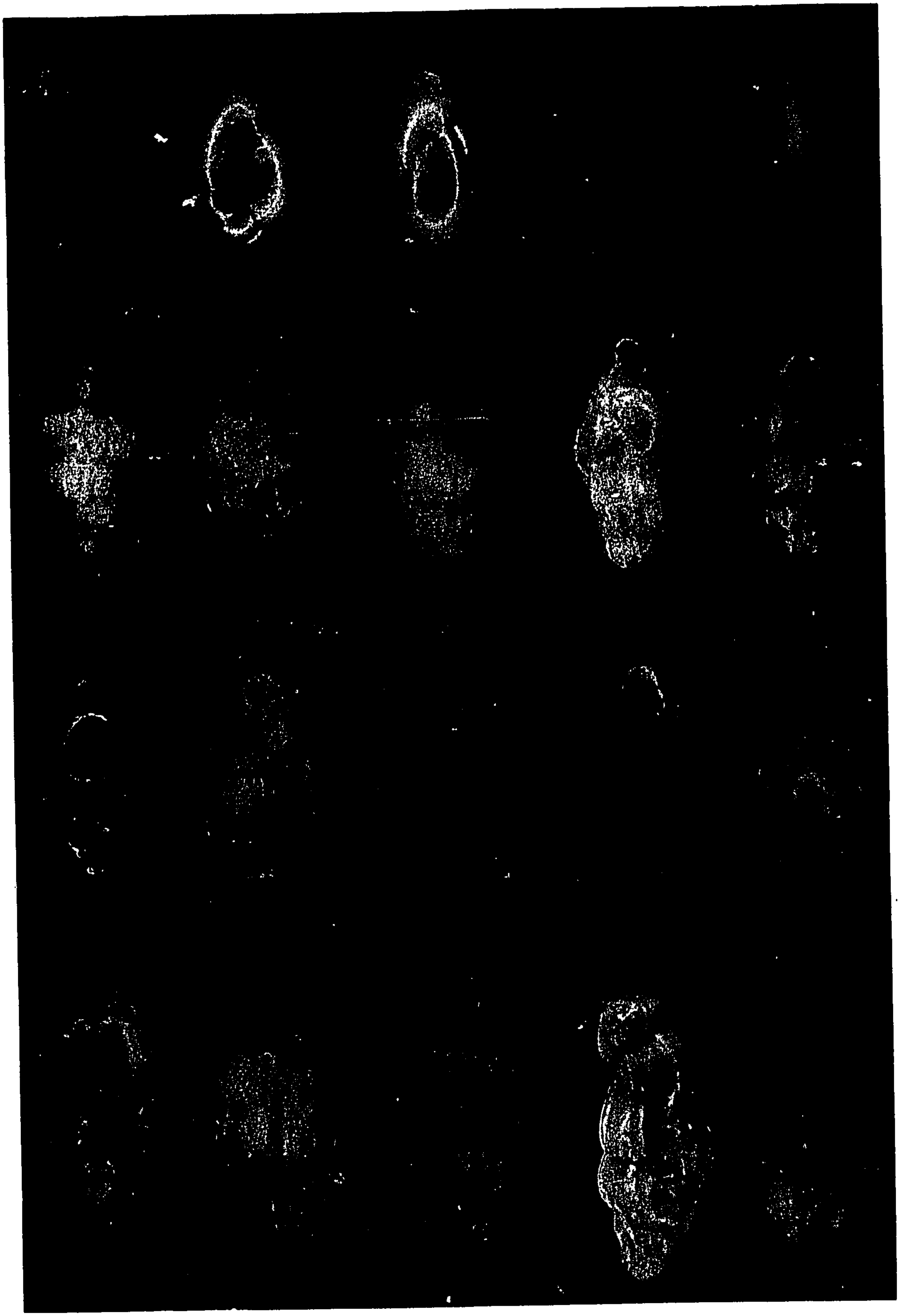


Plate XI

Plate XII

Figure

1, 2. Angulogerina vicksburgensis Cushman; side views, X 50; Red Bluff at locality 4, sample 4

3. Angulogerina danvillensis Howe & Wallace; side view, X 50; Shubuta at locality 1, sample 13

4. Angulogerina sp. 1; side view, X 50; Pachuta at locality 1, sample 16

5. Angulogerina byramensis (Cushman); side view, X 50; Red Bluff at locality 2, sample 7

6, 7. Bitubulogenerina howei Cushman; side views, X 100; Marianna at locality 6, sample 2

8. Chiloguembelina cubensis (Palmer); side view, X 100; Shubuta at locality 1, sample 13

9. Bolivina jacksonensis Cushman & Applin; side view, X 75; Shubuta at locality 4, sample 7

10. Bolivina mississippiensis Cushman; side view, X 50; Red Bluff at locality 4, sample 4

11. Bolivina dalli (Cushman); side view, X 50; Shubuta at locality 1, sample 13

12. Loxostomum vicksburgensis Cushman; side view, X 75; Marianna at locality 3, sample 1

13. Bolivina gracilis Cushman & Applin; side view, X 50; Shubuta at locality 1, sample 10

14. Bolivinella sp. 1; side view, X 50; Red Bluff at locality 2, sample 6

15. Bolivinella subpectinata Cushman; side view, X 50; Red Bluff at locality 2, sample 4

16. Bolivina taylori Howe; side view, X 50; Pachuta at locality 4, sample 12

17. Bolivina alazanensis Cushman; side view, X 50; Shubuta at locality 1, sample 12

18. Bolivina sp. 1; side view, X 50; Shubuta at locality 4, sample 8

19. Bolivina striatellata Cushman & Applin; side view, X 50; Shubuta at locality 1, sample 13

20. Bolivina retifera Bandy; side view, X 50; Shubuta at locality 4, sample 9

21. Stilostomella cocoaensis (Cushman); side view, X 40; Shubuta at locality 1, sample 11

22, 23. Fursenkoina dibollensis (Cushman & Applin); side views, X 75; Pachuta at locality, sample 16

24, 25. Marginulina cocoaensis Cushman; side views, X 40; Shubuta at locality 1, sample 13

26. Marginulina laeviuscula Cushman & Bermudez; side view, X 50; Shubuta at locality 1, sample 11

27. Chilostomella cylindroides Reuss; side view, X 50; Shubuta at locality 1, sample 14

28. Vaginulinopsis sp. 1; side view, X 50; Shubuta at locality 1, sample 14

29. Marginulina sp. 1; side view, X 50; Shubuta at locality 4, sample 8

30. *Vaginulina costifera* (Cole); side view, X 100; Shubuta at locality 1, sample 13

31. *Vaginulina* sp. 1; side view, X 40, Marianna at locality 5, sample 2

32. *Vaginulina lalickeri* (Cushman); side view, X 50; Red Bluff at locality 2, sample 6

33. *Stilostomella jacksonensis* (Cushman & Applin); side view, X 40; Shubuta at locality 1, sample 13

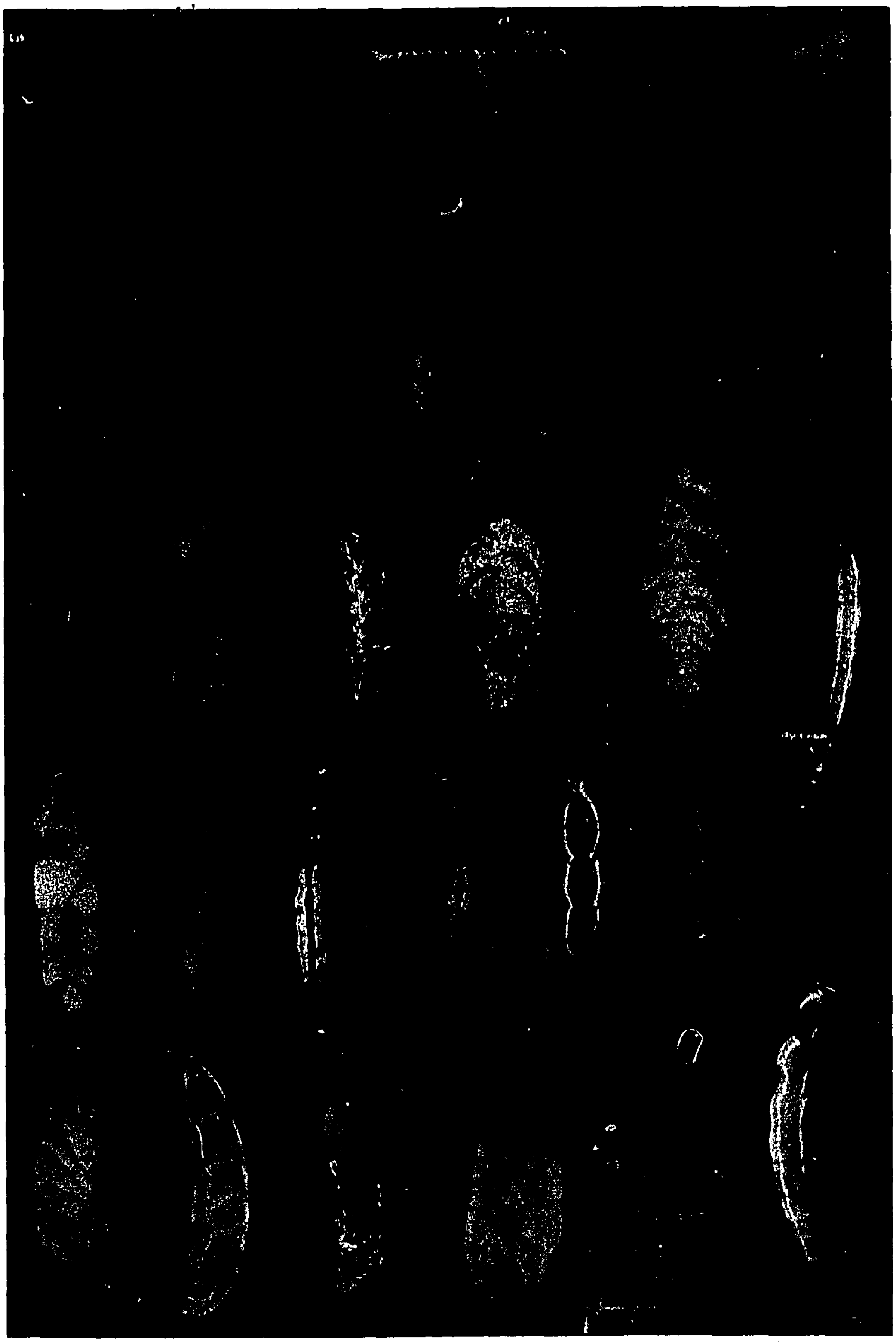


Plate XII

Plate XIII

Figure

1, 2. Pseudoglandulina ovata (Cushman); side views, X 50; Shubuta at locality 1, sample 14

3. Saracenaria hantkeni Cushman; side view, X 50; Shubuta at locality 1, sample 13

4. Saracenaria ornatula Cushman & Bermudez; side view, X 50; Shubuta at locality 1, sample 11

5. Saracenaria sp. 1; side view, X 50; Marianna at locality 4, sample 2

6, 7. Pseudoglandulina conica (Neugeboren); side views, microspheric form (fig. 6), megalospheric form (fig. 7), X 50; Shubuta at locality 1, sample 12

8. Saracenaria sp. 2; side view, X 30; Shubuta at locality 5, sample 9

9. Marginulina hantkeni Bandy; side view, X 50; Shubuta at locality 1, sample 10

10. Marginulina multiplicata Bergquist; side view, X 75; Shubuta at locality 4, sample 8

11. Marginulinopsis sp. 1; side view, X 30; Mint Spring at locality 3, sample 3

12, 13. Astacolus danvillensis (Howe & Wallace); side views, X 50; Shubuta at locality 1, sample 12

14. Marginulina digitalis Bandy; side view, X 75; Red Bluff at locality 7, sample 6

15. Robulus inusitatus Cushman; side view, X 30; Shubuta at locality 1, sample 13

16. *Lenticulina convergens* (Bornemann); side view, X 50; Pachuta at locality 1, sample 16

17. *Marginulinopsis* sp. 1; side view, X 30; Mint Spring at locality 3, sample 3

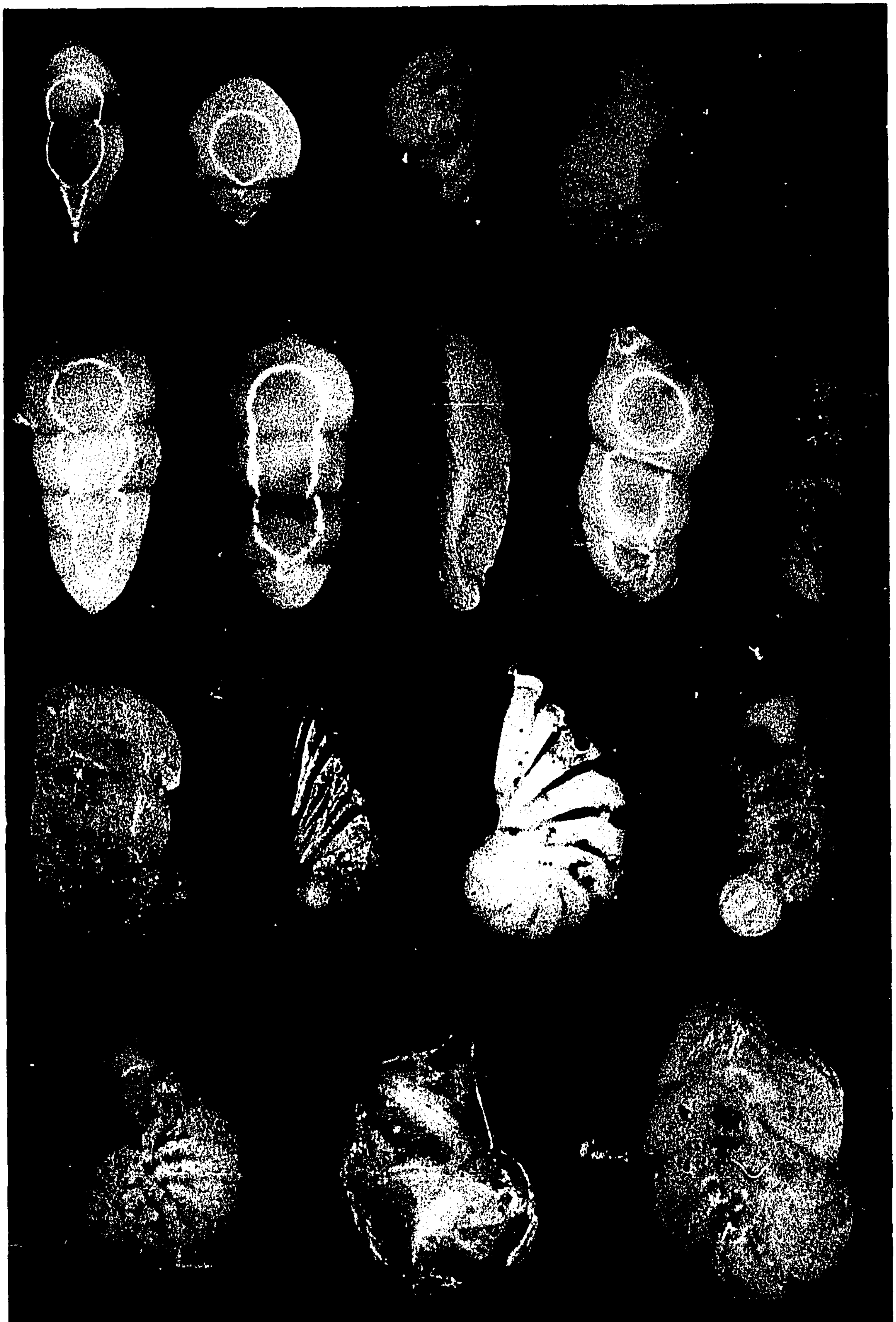


Plate XIII

Plate XIV

Figure

1. *Robulus vicksburgensis* (Cushman); side view, X 60; Marianna at locality 4, sample 1

2. "*Darbyella*" *danvillensis* (Howe & Chambers); side view, X 50; Shubuta at locality 1, sample 14

3. *Robulus rectidorsatus* Bandy; side view, X 50; Shubuta at locality 1, sample 13

4. *Robulus cultratus* Montfort; side view, X 50; Shubuta at locality 1, sample 13

5. *Robulus carolinianus* Cushman; side view, X 50; Red Bluff at locality 2, sample 5

6. *Robulus limbosus* (Reuss); side view, X 30; Shubuta at locality 1, sample 13

7. *Robulus clericii* (Fornasini); side view, X 50; Shubuta at locality 5, sample 9

8, 9. *Planorbulina larvata* Parker & Jones; side view, X 50; Mint Spring at locality 3, sample 3

10. *Robulus davisi* Bandy; side view, X 50; Shubuta at locality 5, sample 9

11, 12. *Cancris* sp. 1; ventral view (fig. 11), dorsal view (fig. 12), S 50; Mint Spring at locality 3, sample 3

13, 14. *Cancris cocoaensis* Cushman; dorsal view (fig. 13), ventral view (fig. 14), X 50; Shubuta at locality 1, sample 13

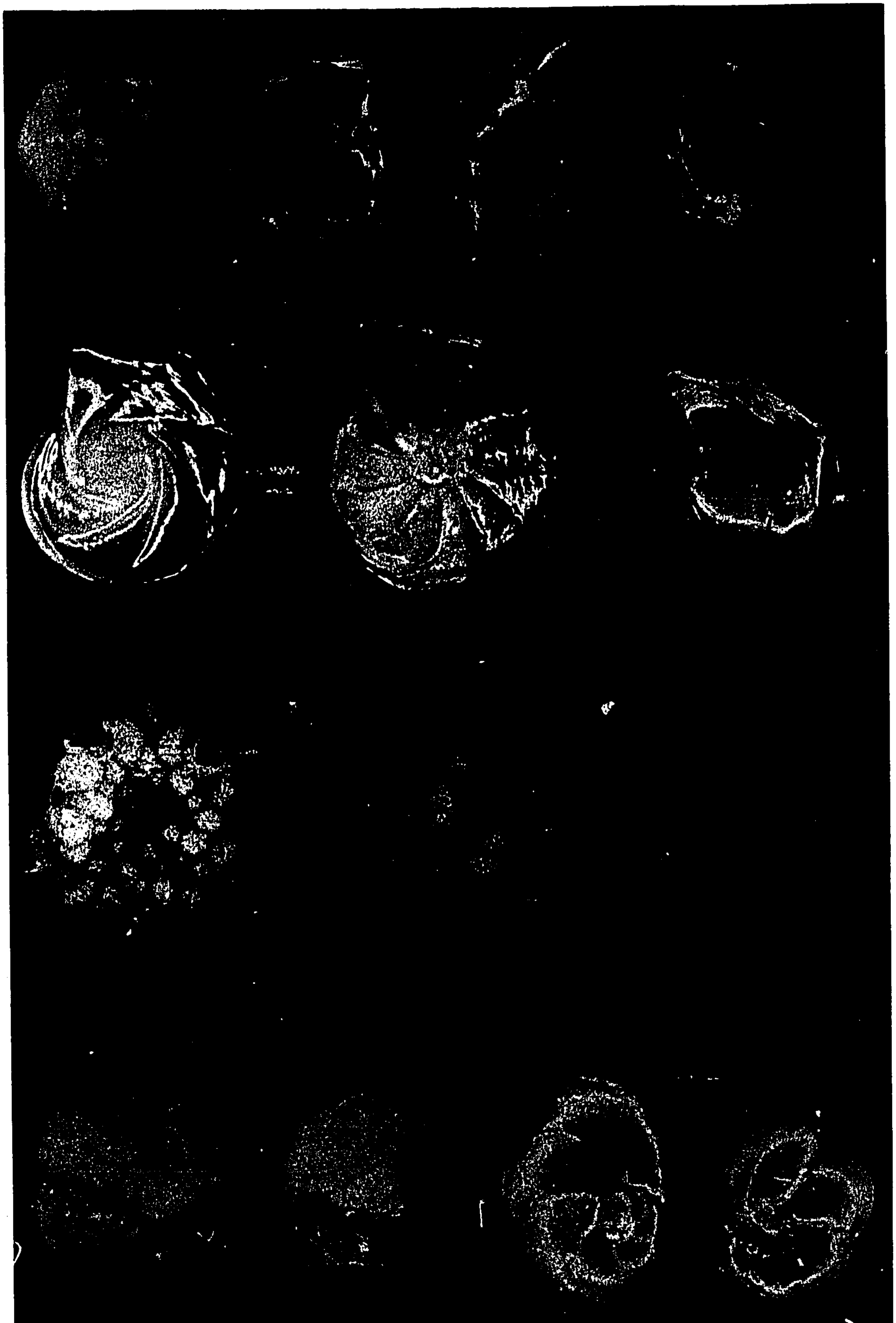


Plate XIV

Plate XV

Figure

1, 2. Ceratobulimina alazanensis Cushman; dorsal view (fig. 1), ventral view (fig. 2), X 60; Shubuta at locality 5, sample 10

3. Pullenia subcarinata (d'Orbigny); side view, X 60; Shubuta at locality 1, sample 10

4, 5. Discorbitura dignata Bandy; dorsal view (fig. 4), ventral view (fig. 5), X 60; Mint Spring at locality 3, sample 3

6, 7. Siphonina danvillensis Howe & Wallace; ventral view (fig. 7), X 60; Shubuta at locality 1, sample 13

8, 9. Siphonina advena Cushman; dorsal view (fig. 8), ventral view (fig. 9), X 60; Red Bluff at locality 5, sample 4

10. Siphonina advena eocenica Cushman & Applin; dorsal view, X 60; Cocoa at locality 1, sample 17

11, 12. Asterigerina gallowayi Bandy; ventral view (fig. 11), dorsal view (fig. 12), X 60; Shubuta at locality 5, sample 11

13, 14. Alabamina wilcoxensis Toulmin; ventral view (fig. 13), dorsal view (fig. 14), X 60; Red Bluff at locality 2, sample 5

15, 16. Lamarckina byramensis Cushman; ventral view (fig. 15), dorsal view (fig. 16), X 60; Red Bluff at locality 2, sample 4

17, 18. Discorbis cocoaensis Cushman & Garrett; ventral view (fig. 17), dorsal view (fig. 18), X 50; Shubuta at locality 1, sample 13

19, 20. Epistomina elegens (d'Orbigny); ventral view (fig. 19), dorsal view (fig. 20), X 50; Shubuta at locality 1, sample 13

21, 22. Eponides jacksonensis (Cushman & Applin); dorsal view (fig. 21), ventral view (fig. 22), X 50; Cocoa at locality 1, sample 17

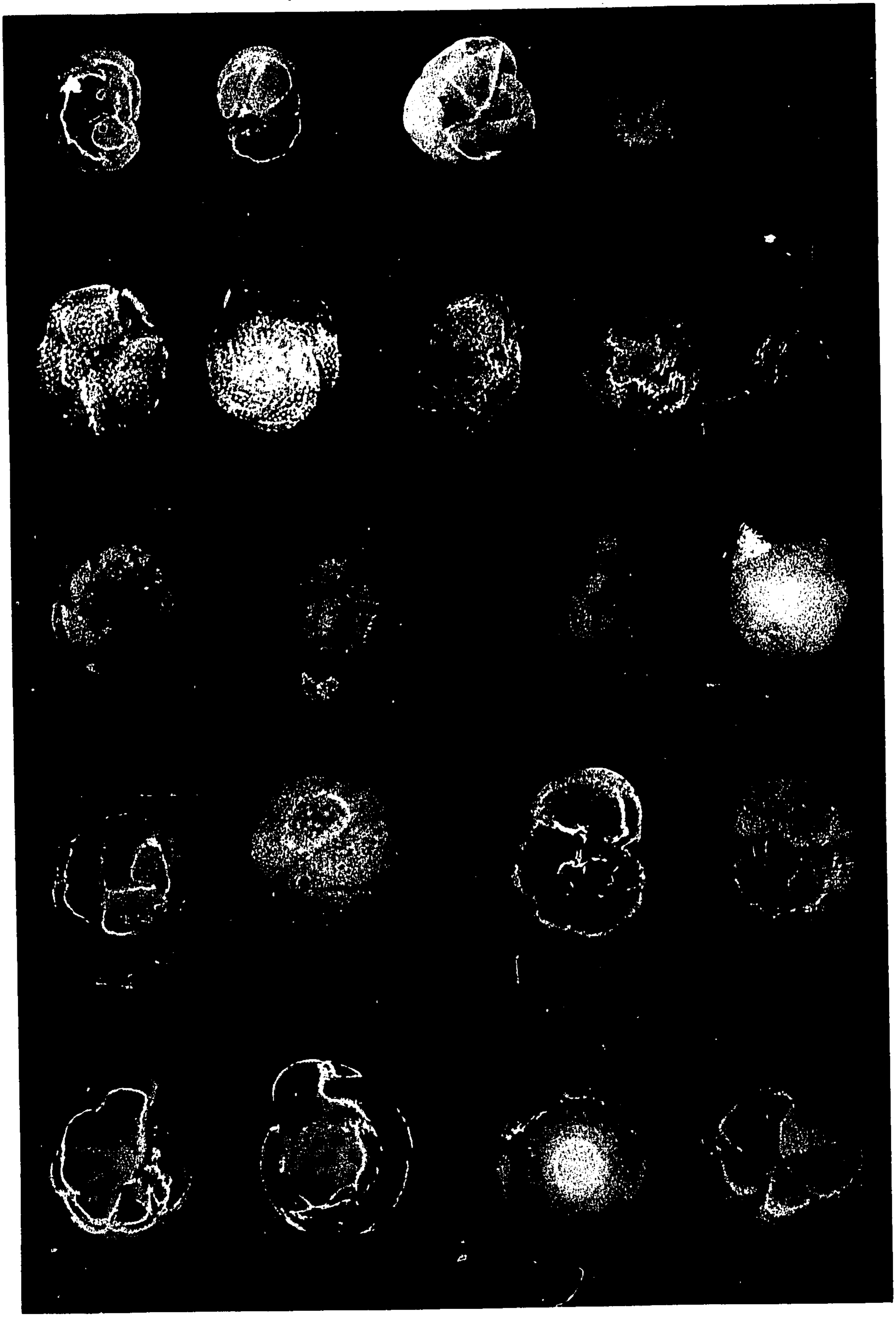


Plate XV

Plate XVI

Figure

1, 2. *Eponides* sp. 1; dorsal view (fig. 1), ventral view (fig. 2), X 50; Marianna at locality 4, sample 1.

3, 4. *Eponides obesa* (Bandy); dorsal view (fig. 3), dorsal view (fig. 4), X 50; Red Bluff at locality 2, sample 6

5, 6. *Eponides byramensis* Cushman; dorsal view (fig. 5), ventral view (fig. 6), X 50; Marianna at locality 5, sample 1

7. *Eponides mariannaensis* Cushman; dorsal view, X 50; Marianna at locality 4, sample 1

8, 9. *Planulina cocoaensis* Cushman; dorsal view (fig. 8), ventral view (fig. 9), X 50; Shubuta at locality 4, sample 11

10. *Eponides mariannaensis* Cushman; ventral view, X 50; Marianna at locality 4, sample 1

11, 12. *Planulina lobatulus* (d'Orbigny); ventral view (fig. 11), dorsal view (fig. 12), X 50; Cocoa at locality 1, sample 17

13, 14. *Planulina cooperensis* Cushman; dorsal view (fig. 13), ventral view (fig. 14), X 50; Shubuta at locality 4, sample 11

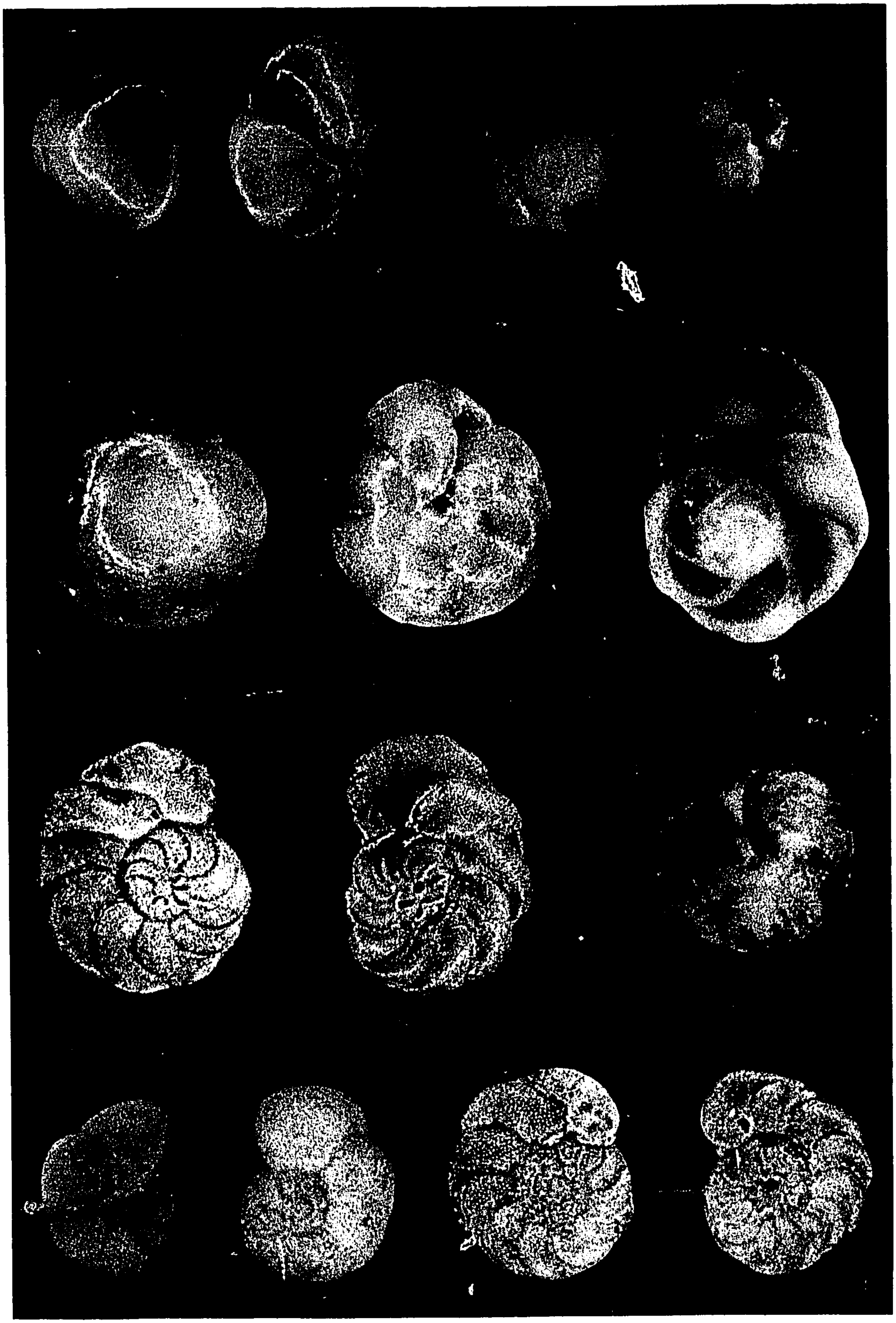


Plate XVI

Plate XVII

Figure

1, 2. Anomalina cocoaensis Cushman; dorsal view (fig. 1), ventral view (fig. 2), X 50; Shubuta at locality 4, sample 11

3, 4. Anomalina danvillensis Howe & Wallace; dorsal view (fig. 3), ventral view (fig. 4), X 60; Shubuta at locality 1, sample 13

5, 6. Anomalina bilateralis Cushman; dorsal view (fig. 5), ventral view (fig. 6), X 50; Red Bluff at locality 2, sample 6

7, 8. Cibicides cocoaensis (Cushman); ventral view (fig. 7), dorsal view (fig. 8), X 50; Shubuta at locality 4, sample 11

9, 10. Cibicides sp. 1; ventral view (fig. 9), dorsal view (fig. 10), X 50; Pachuta at locality 4, sample 12

11, 12. Cibicides sp. 2; ventral view (fig. 11), dorsal view (fig. 12), X 50; Marianna at locality 5, sample 2

13, 14. Cibicides pippeni Cushman & Garrett; dorsal view (fig. 13), ventral view (fig. 14), X 50; Red Bluff at locality 2, sample 6

15, 16. Cibicides pseudoungerianus (Cushman); ventral view (fig. 15), dorsal view (fig. 16), X 50; Mint Spring at locality 3, sample 3

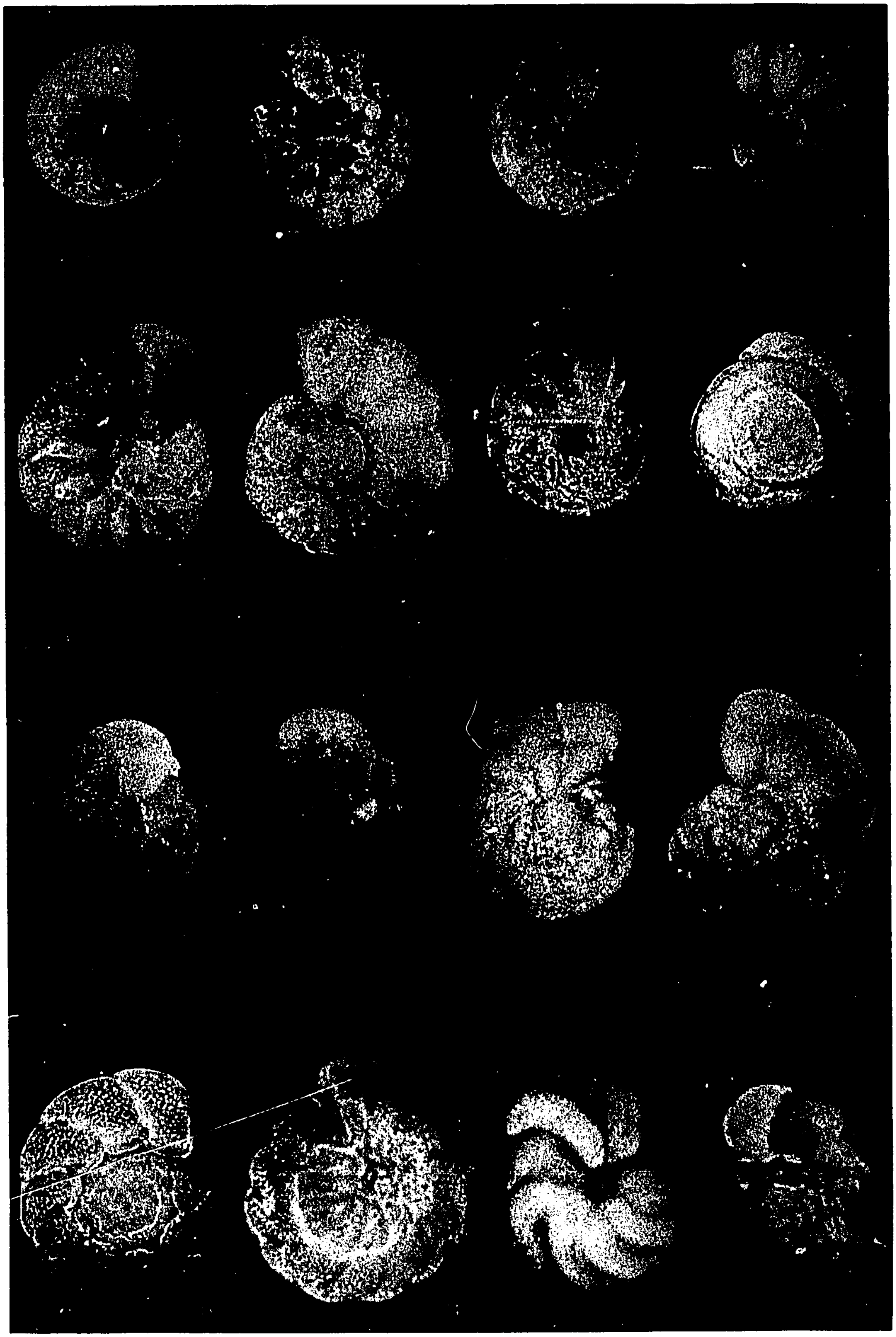


Plate XVII

Plate XVIII

Figure

1. *Cibicides pippeni stavensis* Bandy; dorsal view, X 50; Red Bluff at locality 2, sample 7

2, 3. *Hanzawaia* sp. 1; ventral view (fig. 2), dorsal view (fig. 3), X 50; Marianna at locality 6, sample 1

4. *Hanzawaia* sp. 2; ventral view, X 50; Forest Hill at locality 4, sample 3

5. *Cibicides pippeni stavensis* Bandy; ventral view, X 50, Red Bluff at locality 2, sample 7

6, 7. *Hanzawaia mississippiensis* (Cushman); dorsal view (fig. 6), ventral view (fig. 7), X 50; Marianna at locality 3, sample 1

8. *Hanzawaia* sp. 2; dorsal view, X 50; Forest Hill at locality 4, sample 3

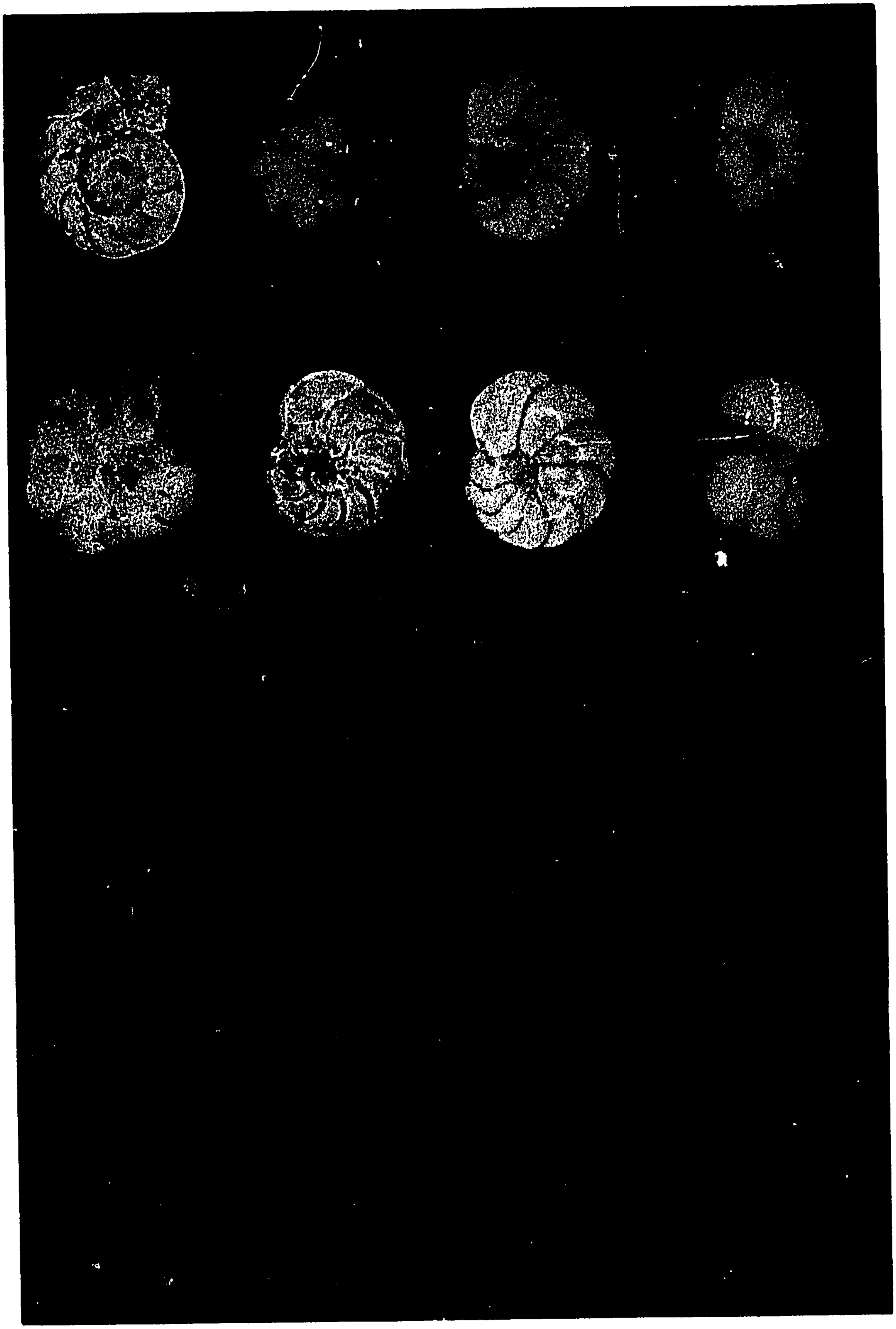


Plate XVIII

VITA

Phili B. Deboo was born in Bombay, India on December 5, 1932. He received his grammer and high school education at the St. Xavier's High School, Bombay, India and was graduated in 1948. He received his B.S. degree from St. Xavier's College, University of Bombay in 1953 majoring in geology and minoring in chemistry. He entered graduate school at Louisiana State University and received his M.S. degree in geology in 1955. He is a candidate for the degree of Doctor of Philosophy in June, 1963.

EXAMINATION AND THESIS REPORT

Candidate: Phili B. Deboo

Major Field: Geology

Title of Thesis: BIOSTRATIGRAPHIC CORRELATION OF THE TYPE SHUBUTA AND RED BLUFF CLAYS WITH THEIR EQUIVALENTS IN SOUTHWESTERN ALABAMA

Approved:

[illegible] & AHChe[illegible]

Major Professor and Chairman

Max Goodrich

Dean of the Graduate School

EXAMINING COMMITTEE:

[illegible] Sandberg

H.V. Andersen

C. O. Durham Jr

Date of Examination:

May 8, 1963